DOCUMENT RESUME

ED 344 106 CE 060 943

AUTHOR Humphrey, John Kevin
TITLE Crop Science. Instructor Guide and Student Reference. Volume 24, Numbers 5 and 6.
INSTITUTION Missouri Univ., Columbia. Instructional Materials Lab.
SPONS AGENCY Missouri State Dept. of Elementary and Secondary Education, Jefferson City. Div. of Vocational and Adult Education.
PUB DATE Jan 92
NOTE 142p.
AVAILABLE FROM Instructional Materials Laboratory, University of Missouri, 2316 Industrial Drive, Columbia, MO 65202 (instructor guide, order no. 10-1035-I; student reference, order no. 10-1035-S).
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052) -- Guides - Classroom Use - Instructional Materials (For Learner) (051)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Agricultural Education; *Agricultural Production; *Agronomy; Competency Based Education; Grains (Food); *Harvesting; *Horticulture; Instructional Materials; Pesticides; Pests; *Plant Identification; Secondary Education; Teaching Guides; Weeds
IDENTIFIERS Forage Crops; Insects; Irrigation

ABSTRACT

This document consists of two separately published guides for a course on crop science: an instructor's guide and a student's reference manual. Each part contains nine lessons on the following topics: (1) economic importance of crops; (2) crop uses (products and byproducts); (3) plant and seed identification; (4) certified seed and variety selection; (5) stand establishment; (6) managing the crop; (7) harvesting and storing grains; (8) harvesting and storing forages; and (9) controlling crop pests. Introductory matter in the instructor's guide includes: major competency profile; sections: objectives; competencies; motivational technique or interest approach; evaluation; and references and materials. Each lesson in the instructor's guide contains some or all of the following: objective; study questions; references; teaching procedures--introduction, motivation, assignment, supervised study, discussion, other activities, conclusion, competency, answers to evaluation, and answers to work sheet; evaluation; and transparency masters. Each lesson in the student reference manual consists of lesson contents, summary, credits, tables, and figures. (NLA)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

10-1035-I

MISSOURI AGRICULTURAL EDUCATION

Instructor Guide

Crop Science

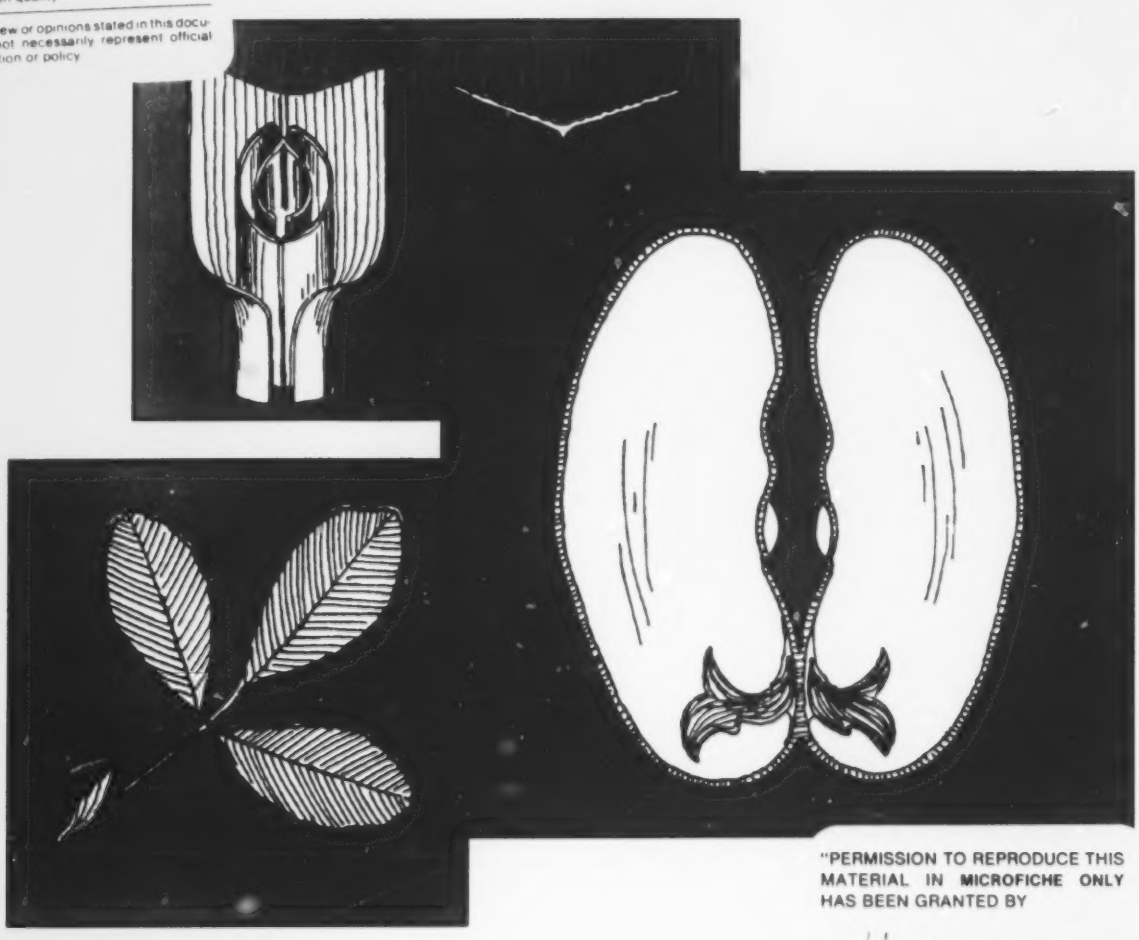
U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED344106



"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

H Schlechting

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

CE060943

In cooperation with Agricultural Education
Department of Practical Arts and
Vocational-Technical Education
College of Education and
College of Agriculture, Food and Natural Resources
University of Missouri - Columbia

In cooperation with
Agricultural Education Section
Division of Vocational and Adult Education
Department of
Elementary and Secondary Education
Jefferson City, Missouri

BEST COPY AVAILABLE

Available from:
Instructional Materials Laboratory
University of Missouri-Columbia
10 London Hall
Columbia, MO 65211
314-882-2883

The activity which is the subject of this report was supported in whole or in part by funds from the Department of Elementary and Secondary Education, Division of Vocational and Adult Education. However, the opinions expressed herein do not necessarily reflect the position or policies of the Missouri Department of Elementary and Secondary Education or the Division of Vocational and Adult Education, and no official endorsement should be inferred.

Instructor Guide

CROP SCIENCE

Writer:
John Kevin Humphrey
Instructional Materials Laboratory
University of Missouri-Columbia

Consulting Editor:
Robert J. Birkenholz
Agricultural Education
University of Missouri-Columbia

Editor and Project Coordinator:
Veronica Fellner
Instructional Materials Laboratory
University of Missouri-Columbia

Available from:
Instructional Materials Laboratory
University of Missouri-Columbia
10 London Hall
Columbia, Missouri 65211

Volume 24
Number 5

Catalog Number 10-1035-I
January 1992

ACKNOWLEDGMENTS

Recognition is given to advisory committee members for providing their valuable time and suggestions in developing this Crop Science unit. The committee consisted of Matt Biddle, Bob Buehler, Dan Forster, Steven King, Delbert Lund, Richard Mattas, Bob McGraw, Charles Parkes, Bill Roberts, Brenda Smith, and Jim Welker.

Appreciation is expressed to the following staff members of the Instructional Materials Laboratory for their efforts in producing this material: Harley Schlichting, Director; Amon Herd, Associate Director; Phyllis Miller, Assistant Director; Dan Stapleton, Assistant Director; Sharon Dyer, Graphic Designer; Lori Holliday and Tracy Stock, Word Processors; and Wei Li, Graduate Assistant.

Veronica Feilner, Editor and Project Coordinator
Instructional Materials Laboratory
University of Missouri-Columbia

Robert R. Birkenholz, Assoc. Professor
Agricultural Education
University of Missouri-Columbia

FOREWORD

The development of the Crop Science unit is the result of suggestions by the MVATA Teaching Aids Committee. The Plant and Crop Science Advisory Committee suggested the topics to be included and reviewed the materials.

This instructor's guide and the corresponding student reference contain nine lessons: Economic Importance of Crops; Crop Uses (Products and By-Products); Plant and Seed Identification; Certified Seed and Variety Selection; Stand Establishment; Managing the Crop; Harvesting and Storing Grains; Harvesting and Storing Forages; and Controlling Crop Pests. It is designed to be taught to ninth or tenth grade students. Transparency masters and work sheets have been included where appropriate. Additional student reference copies can be purchased separately.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

This guide incorporates the needed component parts to aid agriculture teachers in the implementation of VIMS. For ease of use, performance objectives and competencies have been included at the beginning of the unit as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for convenient record keeping.

Bob R. Stewart, Professor and Coordinator
Agricultural Education
University of Missouri-Columbia

Terry Heiman, Director
Agricultural Education
Department of Elementary and
Secondary Education

UNIT - CROP SCIENCE

TABLE OF CONTENTS

ACKNOWLEDGMENTS ii

FOREWORD iii

COMPETENCY PROFILE ix

Lesson 1--Economic Importance of Crops 1
Lesson 2--Crop Uses (Products and By-Products) 9
Lesson 3--Plant and Seed Identification 17
TM 3.1: A Bean Seed
TM 3.2: A Cereal Grain
TM 3.3: Leaf Characteristics of Some Legumes
TM 3.4: Parts of a Grass Plant
TM 3.5: Features of a Grass Leaf
TM 3.6: Leaf Characteristics of Three Grass Species
WS 3.1: Parts of a Bean Seed and Cereal Grain
WS 3.2: Parts of Grass Plant and Leaf
WS 3.3: Characteristics of Selected Crop and Weed Plants
WS 3.4: Seed Identification Score Sheet
Lesson 4--Certified Seed and Variety Selection 45
Lesson 5--Stand Establishment 55
Lesson 6--Managing the Crop 63
Lesson 7--Harvesting and Storing Grains 71
Lesson 8--Harvesting and Storing Forages 79
TM 8.1: Yield and Quality In Forages
Lesson 9--Controlling Crop Pests 89

OBJECTIVES

1. The student will be able to describe the economic importance of crop production.
2. The student will be able to identify how crops are used.
3. The student will be able to identify common plants and seeds in Missouri.
4. The student will be able to identify characteristics of quality seed.
5. The student will be able to explain the requirements for establishing a crop stand.
6. The student will be able to describe good crop production practices.
7. The student will be able to explain factors related to harvesting and storing quality grain.
8. The student will be able to describe factors related to harvesting and storing quality forages.
9. The student will be able to describe methods of plant pest control.

NOTE: Percent of accuracy should be set by instructors to reflect passing grades within their school systems.

COMPETENCIES

1. Describe the economic importance of crop production.
2. Identify how crops are used.
3. Identify common plants and weeds in Missouri.
4. Identify characteristics of quality seed.
5. Explain the requirements for establishing a crop stand.
6. Describe good crop production practices.
7. Explain factors related to harvesting and storing quality grain.
8. Describe factors related to harvesting and storing quality forages.
9. Describe methods of plant pest control.

MOTIVATIONAL TECHNIQUE OR INTEREST APPROACH

1. Ask students how many varieties of the predominate crop (e.g., corn and soybeans) are grown in their state and area. (The instructor can obtain this information from the local University Extension office.) Ask students why different varieties are grown and which are best-suited to the local area.
2. Obtain samples of available corn seed varieties from the local agricultural seed supply company. Place the seeds in clear jars so that students can visually inspect the seeds for differences. Discuss how varieties are developed and why different varieties are developed. Discuss the originating parent plants and the importance of genetic diversity. (There is an article in the National Geographic, April 1991, Vol. 170, No. 4 issue, pages 74 - 105.)
3. Obtain several different types of hay (e.g., clover, clover and fescue, and alfalfa) from local producers. Bring them to class so that students can identify the types of forages contained in the hay.

EVALUATION

1. Give short, objective tests following each lesson and a more in-depth objective test at the conclusion of the unit.
2. Observe the changes in behavior as evidence of an improved ability of students to deal with problems in this unit using background information acquired from earlier units.
3. Observe students' attempts to solve similar problems in their supervised agricultural experience programs.

REFERENCES AND MATERIALS

1. Student Reference

Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.

2. Teacher References

a) Brickbauer, E.A.; W.P. Mortenson. Approved Practices in Crop Production. Danville, IL: The Interstate Publishers and Printers, 1978.

b) Broadleaf and Grass and Grasslike Weed Vegetative Identification Keys. Cooperative Extension Service, University of Illinois, n.d.

c) Chapman, S.R.; L.P. Carter. Crop Production: Principles and Practices. San Francisco, CA: W.H. Freeman and Company, 1976.

d) Cooper, E.L. Agriscience: Fundamentals and Applications. Albany, NY: Delmar, 1990.

e) Crop Plants: Color Photos and Descriptions. University of Illinois: Vocational Agriculture Service, 1981. (available from the Instructional Materials Laboratory, University of Missouri-Columbia)

f) Crop Production: Practices and Principles. San Francisco, CA: W.H. Freeman and Co., 1976.

g) Delorit, R.J.; L.J. Greub; H.L. Alhgren. Crop Production. 5th ed. NJ: Prentice-Hall, Inc., 1984.

h) Dierker, W.W. Grasses and Grasslike Plants of Cultivated Fields and Pastures in Missouri. University of Missouri-Columbia: University Extension, n.d.

i) Doll, R.J.; G.H. Miller; R.D. Rees. International Trade and American Agriculture. Federal Reserve Bank of Kansas City Research Department, 1970.

j) Fridline, C.R. Field Crop Nutrition. The Ohio State University: Ohio Agricultural Education Curriculum Materials Service, 1978. (available from the Instructional Materials Laboratory, University of Missouri-Columbia)

k) Grain Drying, Handling and Storage Handbook. 2nd ed. Ames, IA: Midwest Plant Service, 1987. (available from the Missouri Vocational Resource Center)

l) Identification of Grasses and Legumes. University of Missouri-Columbia: Instructional Materials Laboratory, 1980.

m) Kipps, M.S. Production of Field Crops. 6th ed. NY: McGraw-Hill, 1959.

n) McMillen, W. Feeding Multitudes: A History of How Farmers Made America Rich. IL: Interstate Publishers and Printers, 1981.

o) Missouri Agricultural Statistics Service. Missouri Farm Facts. Missouri Department of Agriculture, 1990.

p) Missouri Handbook of Seed Certification Standards. The Missouri Seed Improvement Association.

q) Thomas, G.W.; S.E. Curl; W.F. Bennett. Food and Fiber for a Changing World. IL: Interstate Publishers and Printers, 1976.

r) University of Missouri-Columbia: University Extension agricultural publications

1) RP0089: Annual Broadleaf Weed Seedling Identification
2) G04850: Common Names of Weeds in Missouri Field Crops
3) G04863: Pasture Weeds (Perennials)
4) RP0281: Weeds of the North Central States

3. Audiovisuals (available from the Missouri Vocational Resource Center, University of Missouri-Columbia, 10 London Hall, Columbia, MO 65211)

a) Grasses and Legumes. Slides. University of Missouri, 1974.

b) Fundamentals of Conservation Planning. Slide series. University of Illinois, 1989.

1) Conservation Planning: A Tool for Better Resource Management
2) Controlling Water Erosion with Conservation Planning
3) Controlling Wind Erosion with Conservation Planning
4) Managing Residue to Reduce Erosion
5) The Water Erosion Process
6) The Wind Erosion Process

c) Integrated Pest Management. Video. San Luis Video Publishing, 1988.

d) Integrated Pest Management (IPM) in Agriculture. Video. San Luis Video Publishing, 1988.

e) Pesticides in Agriculture. Video. San Luis Video Publishing, 1988.

f) Soil Erosion. Slides. University of Illinois.

4. Computer Software

a) Agriculture Math Tutor/Crop. ACS Software Publishing, 256 Warner Milne Rd. #4, P.O. Box 5934, Oregon City, OR 97045.

b) Agri ID (leaf and plant). Midwest Agribusiness Services, Inc., 6739 Glacier Drive, West Bend, WI 53095.

c) Calculating Soil Loss. Agri-Education, Inc., Box 456, Stratford, IA 50249.

d) Common Cents Conservation. Agri-Education, Inc., Box 456, Stratford, IA 50249.

e) Conservation Tillage. Agri-Education, Inc., Box 456, Stratford, IA 50249.

f) Hobar Forestry/Related Review. Hobar Publications, 1234 Tiller Lane, St. Paul, MN 55112.

g) Seed Industry Careers. Hobar Publications, 1234 Tiller Lane, St. Paul, MN 55112.

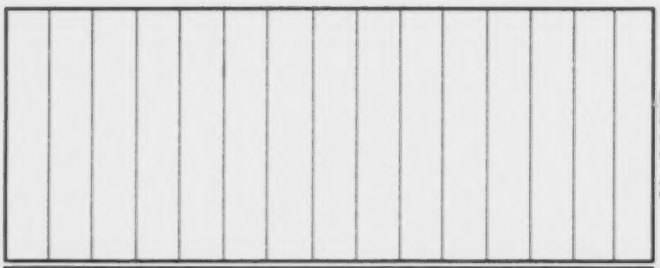
h) Soil Evaluation/Fertility/Related Review. Hobar Publications, 1234 Tiller Lane, St. Paul, MN 55112.

CROP SCIENCE
Major Competency Profile

Directions: Evaluate the student by checking the appropriate number or letter to indicate the degree of competency. The rating for each task should reflect **employability readiness** rather than the grades given in class.

Rating Scale:
- **3 Mastered** - can work independently with no supervision
- **2 Requires Supervision** - can perform job completely with limited supervision
- **1 Not Mastered** - requires instruction and close supervision
- **N No Exposure** - no experience or knowledge in this area

3	2	1	N	Competencies
				1. Describe the economic importance of crop production.
				2. Identify how crops are used.
				3. Identify common plants and weeds in Missouri.
				4. Identify characteristics of quality seeds.
				5. Explain the requirements for establishing a crop stand.
				6. Describe good crop production practices.
				7. Explain factors related to harvesting and storing quality grain.
				8. Describe factors related to harvesting and storing quality forage.
				9. Describe methods of plant pest control.
				_____



Students:

Crop Science
Class/Section:

_____

Competencies
1. Describe the economic importance of crop production.
2. Identify how crops are used.
3. Identify common plants and weeds in Missouri.
4. Identify characteristics of quality seed.
5. Explain the requirements for establishing a crop stand.
6. Describe good crop production practices.
7. Explain factors related to harvesting and storing quality grain.
8. Describe factors related to harvesting and storing quality forage.
9. Describe methods of plant pest control.

UNIT - CROP SCIENCE

Lesson 1: Economic Importance of Crops

Objective: The student will be able to describe the economic importance of crop production.

Study Questions

1. **What are the major crops produced in Missouri?**
2. **How does Missouri rank in crop production in the U.S.?**
3. **What are the major crops produced in the world?**
4. **What factors affect which crops are grown?**
5. **How does crop production impact international relationships?**
6. **How does crop production in other countries affect the U.S.?**
7. **How has the efficiency of crop production affected the development of society?**

Reference

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.

UNIT - CROP SCIENCE

Lesson 1: Economic Importance of Crops

TEACHING PROCEDURES

A. Introduction

Agriculture plays an important role in Missouri's economy. Agriculture also plays an equally important role in trade between the U.S. and other countries. This unit will address the economic importance of crops, crop uses, common crops produced, crop quality, and other related topics.

B. Motivation

The instructor should secure several agricultural food products labeled Agri-Missouri (either the food product or just the package) and have a display ready to be used in introducing this lesson. A list of Agri-Missouri products can be obtained from your local grocer. Using a large map of Missouri, have students locate where each finished, packaged product is from. Next, look at the agricultural ingredients in each product (e.g., wheat, corn, and pork). Using the information from the Missouri Farm Facts booklet, locate the areas that produce the raw products.

Ask students to list the jobs that are involved in processing the products. Discuss the importance of the income received by those employed in processing and the importance of the products to the economy of each community and the state.

C. Assignment

D. Supervised study

E. Discussion

1. Missouri's diverse geography allows for the production of a wide range of agricultural products. From flat land to rolling hills, from low delta land to forested mountains, Missouri is able to produce a variety of crops.

   What are the major crops produced in Missouri?

   a) Soybeans
   b) Corn
   c) Wheat
   d) Grain sorghum
   e) Cotton
   f) Rice
   g) Fescue seed
   h) Lespedeza
   i) Hay

2. Crop production in Missouri plays an important part in the overall production of crops in the U.S. The instructor needs to update information each year. (Data is from the 1990 Missouri Farm Facts.)

How does Missouri rank in crop production in the U.S.?

a) 2nd in hay production - excluding alfalfa
b) 4th in sorghum grain
c) 4th in winter wheat
d) 6th in soybeans
e) 6th in rice (all)
f) 6th in Concord grapes
g) 9th in corn for grain
h) 10th in cotton

3. World trade in agricultural products is important to the U.S. economy. Spices were one of the first goods purchased from foreign lands. Before the new colonies in North America declared independence, crops like tobacco and potatoes were exported to England. Agricultural products were imported from other countries to meet the growing needs of the new colonies. Agricultural trade has increased since the early history of the U.S. and so has the production of agricultural crops by other countries.

What are the major crops produced in the world?

a) Cereal grains (wheat, barley, oats, rye, corn, sorghum, rice)
b) Oilseeds (cotton, soybeans, peanut, canola, rapeseed, sunflower, safflower)
c) Sugar (sugar beets, some sugar cane)
d) Fiber crops (cotton, hemp, flax, jute)

4. The U.S. has been richly endowed with much productive land and a temperate climate. American farmers are able to produce more than what is needed by the people of this nation. The efficient production of agricultural crops holds both benefits and disadvantages for farmers. Discuss what factors affect which crops are grown in a given area.

What factors affect which crops are grown?

a) Land capability and use
b) Climate
c) Resource availability
d) Product demand
e) International trade

5. Differences in natural conditions and economic structures lead to great differences in the cost of production of agricultural products from country to country. Many developing countries depend heavily on agricultural exports for their primary source of earnings. Production of agricultural crops and the ability to export those crops are affected by international agreements and relationships between countries.

How does crop production impact international relationships?

a) Helps stimulate the U.S. economy
b) Helps provide jobs in export/import industries
c) Contributes to the U.S. trade balance
d) Builds allies
e) Overproduction can reduce prices.
f) Overproduction can push developing countries out of the market.
g) Overproduction can increase international tension.
h) Continued trade may result in dependency for developing countries.

6. Although the U.S. is the largest exporter of agricultural products, there has been an increase of competition from countries entering the foreign trade market.

How does crop production in other countries affect the U.S.?

a) Crops not produced in the U.S. may be imported (e.g., teas, coffees, other beverages, and fibers).
b) Excess foreign production may result in surpluses and lower prices.
c) Foreign countries with lower labor costs may make products cheaper for U.S. imports.

7. Development of a society depends on many interrelated factors. Natural resources and energy are among the many factors that will stimulate the growth of a society. However, agriculture and the ability to produce food are the key to economic development.

How has the efficiency of crop production affected the development of society?

a) People and resources are freed up to pursue other endeavors.
b) Less money is spent on food, leaving more money for other purchases.
c) Creation of jobs to meet the demand for other goods and services, which stimulates the economy.
d) Trade is encouraged, which makes other products and opportunities available.
e) Assist other societies to develop.

F. Other activities

1. Have students examine their community to discover how many agricultural products or ingredients are imported.

2. Locate a world map and identify countries that purchase crops from the U.S.

G. Conclusion

Crop production in Missouri affects more than just the local economy. The economic value of crop production stimulates income and trade in the community, state, nation, and other countries. The U.S. owes its strength and greatness to the progressive, hardworking American farmer.

H. Competency

Describe the economic importance of crop production.

I. Answers to Evaluation (Questions 8-15 need to be updated yearly.)

1. T
2. F
3. F
4. T
5. T
6. T
7. F
8. 9th
9. 6th
10. 6th
11. 6th
12. 2nd
13. 4th
14. 10th
15. 4th

UNIT - CROP SCIENCE Name _____

Lesson 1: Economic Importance of Crops Date _____

EVALUATION

True/False (Place the correct response in the blank provided.)

____ 1. Missouri's geography encourages agricultural diversity.

____ 2. Missouri ranks last among other states for sorghum grain production.

____ 3. All rice is produced in Asian countries.

____ 4. Climate is an important factor to consider when choosing which crop to grow.

____ 5. The U.S. is richly endowed with fertile land.

____ 6. Agricultural trade builds allies.

____ 7. Agricultural trade limits social development.

How does Missouri rank in the U.S. in the production of each of the following crops?

	Rank	Crop
8.	____	Corn for grain
9.	____	Rice (all)
10.	____	Soybeans
11.	____	Concord grapes
12.	____	Hay (excluding alfalfa)
13.	____	Winter wheat
14.	____	Cotton
15.	____	Sorghum grain

UNIT - CROP SCIENCE

Lesson 2: Crop Uses (Products and By-Products)

Objective: The student will be able to identify how crops are used.

Study Questions

1. **What are the major uses of crops?**
2. **What are the major crops in each of the major use categories?**
3. **What products are made from corn?**
4. **What products are made from soybeans?**
5. **What characteristics determine how a crop is used?**

Reference

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.

UNIT - CROP SCIENCE

Lesson 2: Crop Uses (Products and By-Products

TEACHING PROCEDURES

A. Review

Review key points from Lesson 1.

B. Motivation

Have samples of several retail products made from one crop (e.g., sweeteners, corn oil, soy-oil, peanut oil, linseed oil, and cottonseed oil), and discuss how the products are used.

C. Assignment

D. Supervised study

E. Discussion

1. As the world population continues to grow, the demand and need for a continual supply of food and agricultural products increases. In order to meet the growing need, agricultural scientists through research and technology continue to develop new products and by-products from crops. Crop plants can be grouped according to how they are used.

What are the major uses of crops?

a) Human and animal consumption (food or feed)
b) Production of various oils (human consumption/industrial use)
c) Medicines (pharmaceuticals)
d) Fibers (cloth, pulp)
e) Sugars/sweeteners
f) Alternative fuels
g) Shelter materials (lumber)
h) Ornamentals
i) Stimulants

2. Write on the chalkboard or overhead projector the major uses of crop plants, and ask the students for suggestions of what crops would belong under each major use area. (List plants suggested by students and also the list below.)

What are the major crops in each of the major use categories?

a) Crops for human and animal consumption (food or feed)
   1) Cereal or grain crops - wheat, rye, barley, oats, rice, sorghum, corn
   2) Legumes for seed - field beans, field peas, peanuts, cowpeas, soybeans
   3) Fruits - apples, peaches, berries, cherries, etc.
   4) Vegetables - tomatoes, cucumbers, squash, etc.
   5) Nuts - pecans, walnuts, etc.
b) Oil crops for human consumption and industrial use: soybeans, peanuts, castor beans, flax, sesame, cottonseed, corn, canola

c) Medicine crops: digitalis, quinine, reserpine
d) Fiber crops: cotton, flax, hemp
e) Sugar crops: sugar cane, sugar beets
f) Alternative fuels: crops that contain sugar or starch for ethanol (corn, etc.)
g) Materials for shelter: timber production
h) Ornamental plants
i) Stimulant crops: tobacco, tea, coffee

3. Although corn is the most widely grown crop throughout the U.S., less than 10 percent is used for human consumption. Corn is used in a variety of products.

What products are made from corn?

a) Livestock feed
b) Cooking oils
c) Breakfast cereals
d) Corn on the cob
e) Corn starch
f) Cornmeal
g) Refined corn sugar
h) Flour
i) Popcorn
j) Adhesives
k) Dyes
l) Plastics
m) Ethanol
n) Others

4. Soybean production has become very important to the U.S. and the world. Since World War II, soybean production has increased in the U.S.

What products are made from soybeans?

a) Cooking oil
b) Soybean meal
c) Soy-flour
d) Tofu (protein supplement)
e) Shortenings
f) Margarines
g) Inks for printing
h) Industrial oils in paints, varnishes, caulking compounds and linoleum
i) Soy sauces
j) Others

5. Controlled production of plant crops plays a key role in the overall process of supplying food to the growing human population. However, not all plants are grown for food. Many plants are grown for specific products. Such plants are produced because of the desirable characteristics they possess.

What characteristics determine how a crop is used?

a) Nutritive value (protein content, carbohydrate content, oil content, etc.) the plant parts
b) Palatability of the plant for food or feed products

c) Use of the plant's parts (stems, leaves, roots, seeds) for the processing of specific products other than food products

F. Other activities

1. Visit a processing plant in the area that uses plant products.

2. Divide students into groups and have them research a selected plant crop and list as many products or by-products from that crop as they can.

3. Using the lists generated in 2 above, write on the chalkboard or overhead all the plant products or by-products that the students would come in contact with on a daily basis.

4. Have each student write a paper on what everyday life would be like without plant products and by-products.

G. Conclusion

Plant crops have many uses. The production of human food, animal feed, various oils, pharmaceuticals, sugars, stimulants, and fibers have been brought about through the manipulation of specific plant characteristics. Researchers continue to broaden the list of products through research and technology.

H. Competency

Identify how crops are used.

I. Answers to Evaluation

1. True
2. True
3. False
4. True
5. FF
6. OC
7. OC, FC
8. MS
9. OC, FF
10. FF, OC, AF
11. OP
12. ST
13. FF
14. SC
15. ST
16. SC, AF
17. MS
18. OP
19. ST
20. FF
21. PH
22. FF
23. FC

UNIT - CROP SCIENCE Name_____

Lesson 2: Crop Uses (Products and By-Products) Date_____

EVALUATION

True/False (Place the correct response in the blank provided.)

____ 1. Crops are used to produce products used by humans, livestock and industry.

____ 2. Corn and soybeans can produce both a grain product and an oil product.

____ 3. Cotton is grown solely for the production of cottonseed oil.

____ 4. Corn is the most commonly grown field crop in the U.S.

Place the two-letter code that corresponds to the use of the plant. Some plants have more than one use.

Foods and feeds for human and animal consumption = FF
Oil crops = OC
Fiber crops = FC
Sugar crops = SC
Stimulant crops = ST
Pharmaceuticals = PH
Alternative fuels = AF
Materials for shelter = MS
Ornamental plants = OP

Crop Plants

____ 5. Wheat

____ 6. Canola

____ 7. Cotton

____ 8. Oak tree

____ 9. Soybeans

____ 10. Corn

____ 11. Goldenrain tree

____ 12. Coffee

____ 13. Tall fescue

____ 14. Sugar cane

____ 15. Tea

____ 16. Sugar beets

____ 17. Pine tree

____ 18. African violet

____ 19. Tobacco

____ 20. Apple tree

____ 21. Foxglove

____ 22. Cucumbers

____ 23. Hemp

UNIT - CROP SCIENCE

Lesson 3: Plant and Seed Identification

Objective: The student will be able to identify common plants and seeds in Missouri.

Study Questions

1. **How are seeds identified?**
2. **What are characteristics of selected crop and weed seeds?**
3. **What are the three classes of weeds in Missouri?**
4. **How are plants identified?**
5. **What are the characteristics of selected crop and weed plants?**

References

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.
2. Transparency Masters
   a) TM 3.1: A Bean Seed
   b) TM 3.2: A Cereal Grain
   c) TM 3.3: Leaf Characteristics of Some Legumes
   d) TM 3.4: Parts of a Grass Plant
   e) TM 3.5: Features of a Grass Leaf
   f) TM 3.6: Leaf Characteristics of Three Grass Species
3. Work Sheets
   a) WS 3.1: Parts of a Bean Seed and Cereal Grain
   b) WS 3.2: Parts of Grass Plant and Leaf
   c) WS 3.3: Characteristics of Selected Crop and Weed Plants
   d) WS 3.4: Seed Identification Score Sheet

UNIT - CROP SCIENCE

Lesson 3: Plant and Seed Identification

TEACHING PROCEDURES

A. Review

Review key points from Lesson 2. This lesson is predominately an activity oriented lesson that requires individual and group activities. It is suggested that references be obtained in order to fully cover the topic of plant and seed identification.

B. Motivation

Divide the class into groups. Give each group a package of mixed seeds (e.g., corn, sunflower, and pinto bean). Have students separate and identify them. Discuss how they identified the seeds and why identification is important.

C. Assignment

D. Supervised study

E. Discussion

1. While the students are divided into groups with the seeds separated, point out to them distinguishing characteristics of specific seeds. Use TM 3.1 and TM 3.2 to aid in this discussion. Have students complete WS 3.1.

   How are seeds identified?

   a) Size
   b) Shape
   c) Color
   d) Surface markings
   e) Other botanical characteristics

2. Select some crop and/or weed seeds that you feel are important and prepare seed samples on paper plates. (NOTE: Seed samples are available through IML.) Have students use the crop and weed seed information sheets in the student reference to identify the seeds.

   What are the characteristics of selected crop and weed seeds?

   a) Crop seeds - (student should use information in student reference)
   b) Weed seeds - (student should use information in student reference)

3. Weeds are plants. However, a weed is any plant that is growing where it is not wanted. Weeds can be classified into groupings for identification.

   What are the three classifications of weeds in Missouri?

   a) Prohibited - weeds that are nearly impossible to control; Missouri law "prohibits" the sale of agricultural seeds which contain "prohibited" weed seeds.

b) Noxious - weeds that can be controlled with some difficulty; the presence of "noxious" weed seed in agricultural seeds is restricted in Missouri.
c) Common - weeds that are relatively easy to control, but reduce crop yields and increase production costs.

4. Identification of plants is important in crop production and weed control. There are several characteristics which can be used to identify crop and weed seeds. Use WS 3.2.

How are plants identified?

a) Life cycle
b) Plant height
c) Leaves
d) Stems
e) Flower
f) Roots

5. Select a few plants that you feel are important and prepare several samples of major field crop and weed plants of Missouri. Be sure to select those plants that display distinct characteristics (e.g., flowers, leaves, roots, and stolons). Use TM 3.3, TM 3.4, and TM 3.5 to discuss the differences of plant characteristics (e.g., pinnately or palmately structured leaves). Have students refer to information in the student reference and use WS 3.3 to answer this question.

What are the characteristics of selected crop and weed plants?

F. Other activities

1. During this lesson, have a daily display of selected seeds in a tray identified only by a number. Have students identify them. Do at least 5 a day until all seeds are identified. Develop a score chart to record student progress. (A classroom contest can be arranged for motivation.) Use WS 3.4.

2. Display pictures of selected crop and weed plants identified only by a number. Have students identify them. Do at least 5 a day until all crops and weeds in lesson are identified.

G. Conclusion

The presence of weeds in crops is costly to the producer. Proper plant identification plays a part in the process of reducing weeds and in turn reducing the damage to crops because of them.

H. Competency

Identify common plants and weeds in Missouri.

I. Answers to Evaluation

Correct answers need to be determined by instructor.

J. Answers to Work Sheets

WS 3.1 - Parts of Bean Seed and Cereal Grain

1. Raphe (d)
2. Hilum (f)
3. Micropyle (g)
4. Cotyledons (c)
5. Seed coat (a)
6. Radicle (b)
7. Shoot (e)
8. Mid vein
9. Callus
10 Suture
11. Awn
12. Apex of palea
13. Lemma
14. Teeth of edge of palea (keel)
15. Palea
16. Rachilla

WS 3.2 - Parts of Grass Plant and Leaf

1. Culm (a)
2. Leaf blade (e)
3. Ligule (b)
4. Sheath (d)
5. Auricles (c)
6. Inflorescence (e)
7. Culm (d)
8. Sheath (b)
9 Roots (c)
10. Leaf blade (a)
11. Node (g)
12. Stolon (f)
13. Rhizome (a)

WS 3.3 - Characteristics of Selected Crop and Weed Plants

Instructor needs to determine if answers are appropriate.

WS 3.4 - Seed Identification Score Sheet

Instructor needs to determine if answers are appropriate.

UNIT - CROP SCIENCE

Name _____

Lesson 3: Plant and Seed Identification

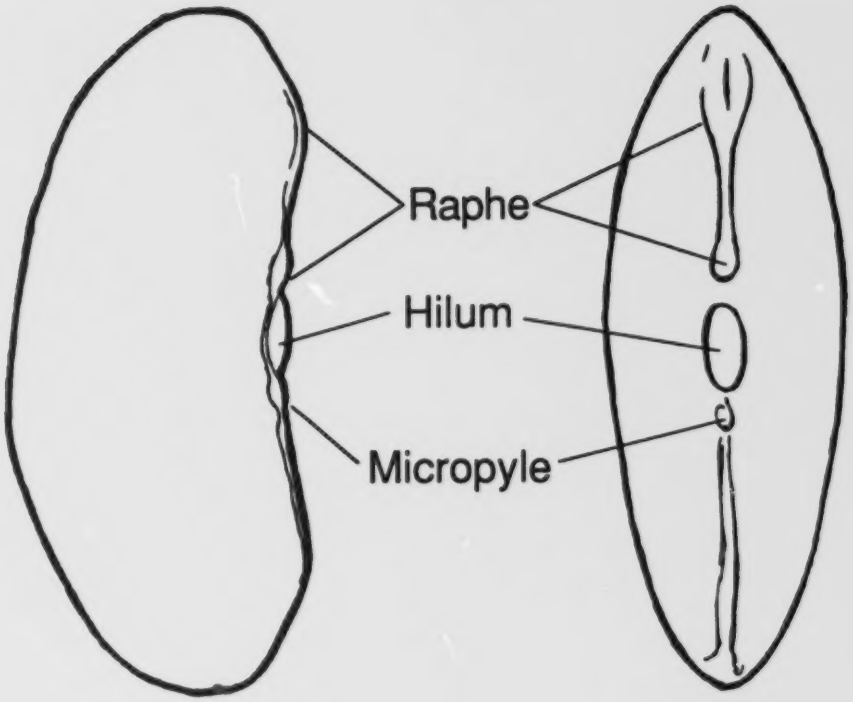
Date _____

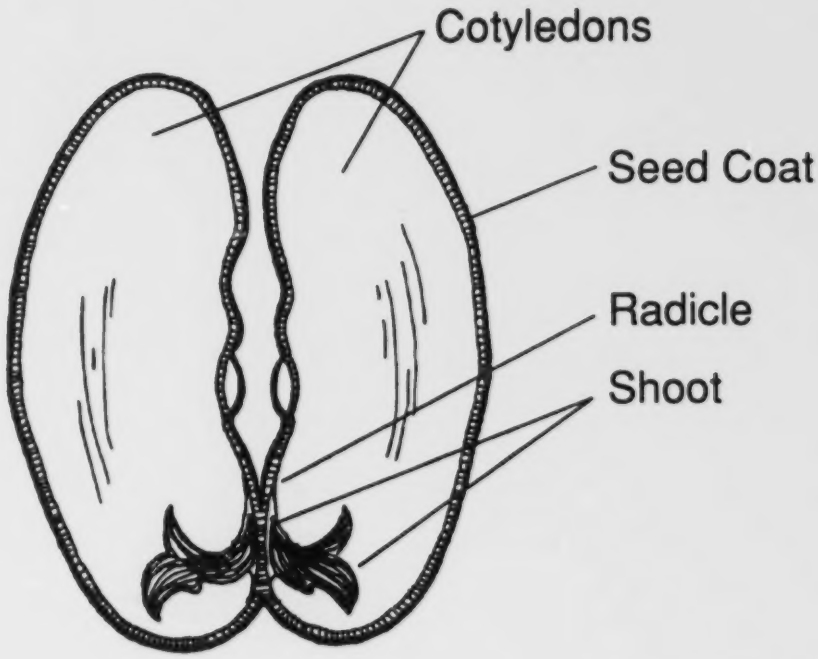
EVALUATION

Identify 10 seeds by their size, shape, color, surface markings and common name of the plant seed.

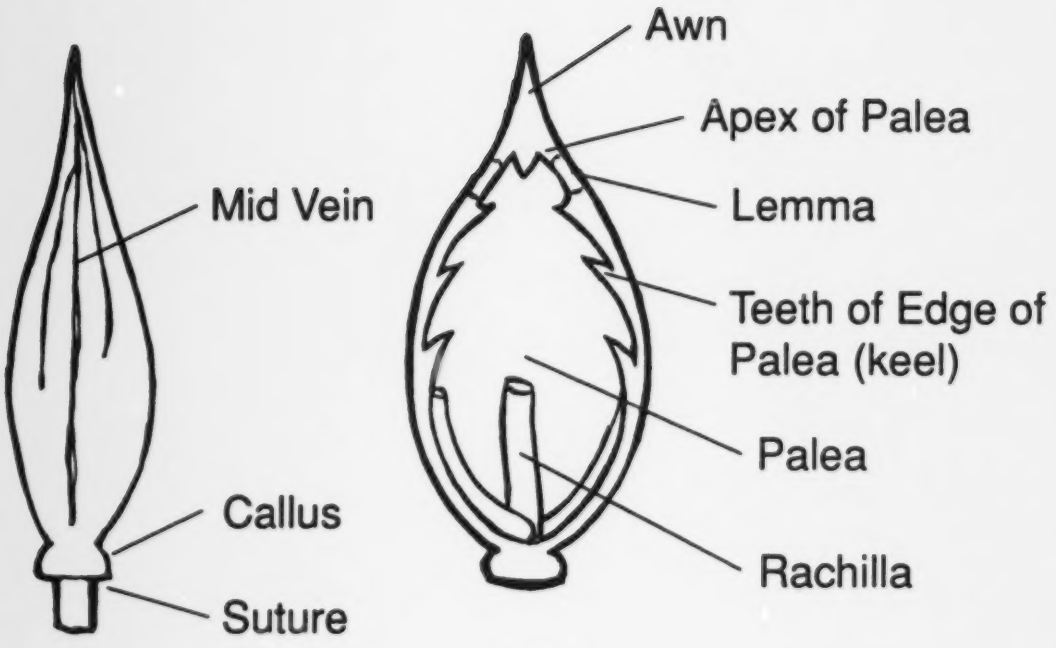
Seed #	Size	Shape	Color	Surface Markings	Name of Plant Seed
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

A Bean Seed





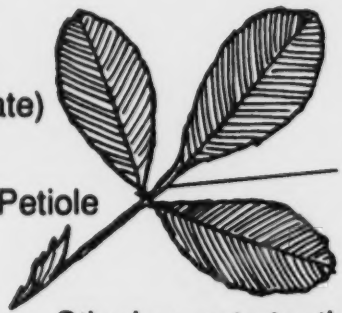
A Cereal Grain



Leaf Characteristics of Some Legumes

Alfalfa

Three leaflets
(Pinnately Trifoliolate)

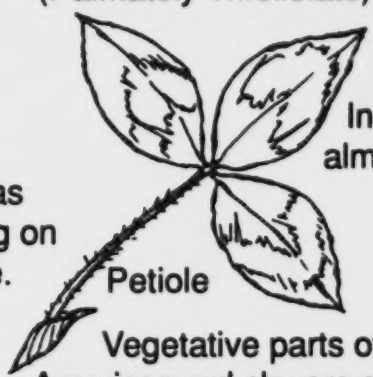


Serrations on outer 1/3 -1/2

Stipules, note teeth, lobes, and sharp-pointed termin

Three leaflets
(Palmately Trifoliolate)

Red Clover

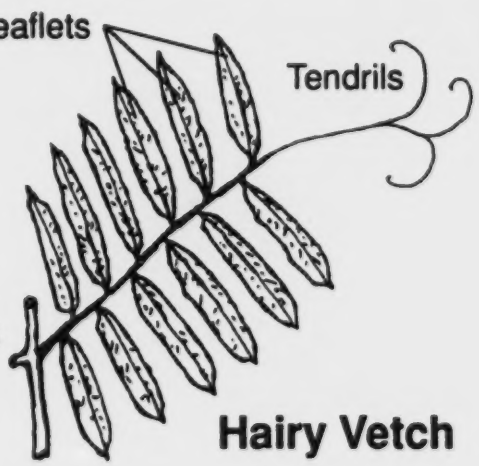


Inverted v-shaped "watermark" almost always present although not always distinct.

Stipule sheath has one prong on each side.

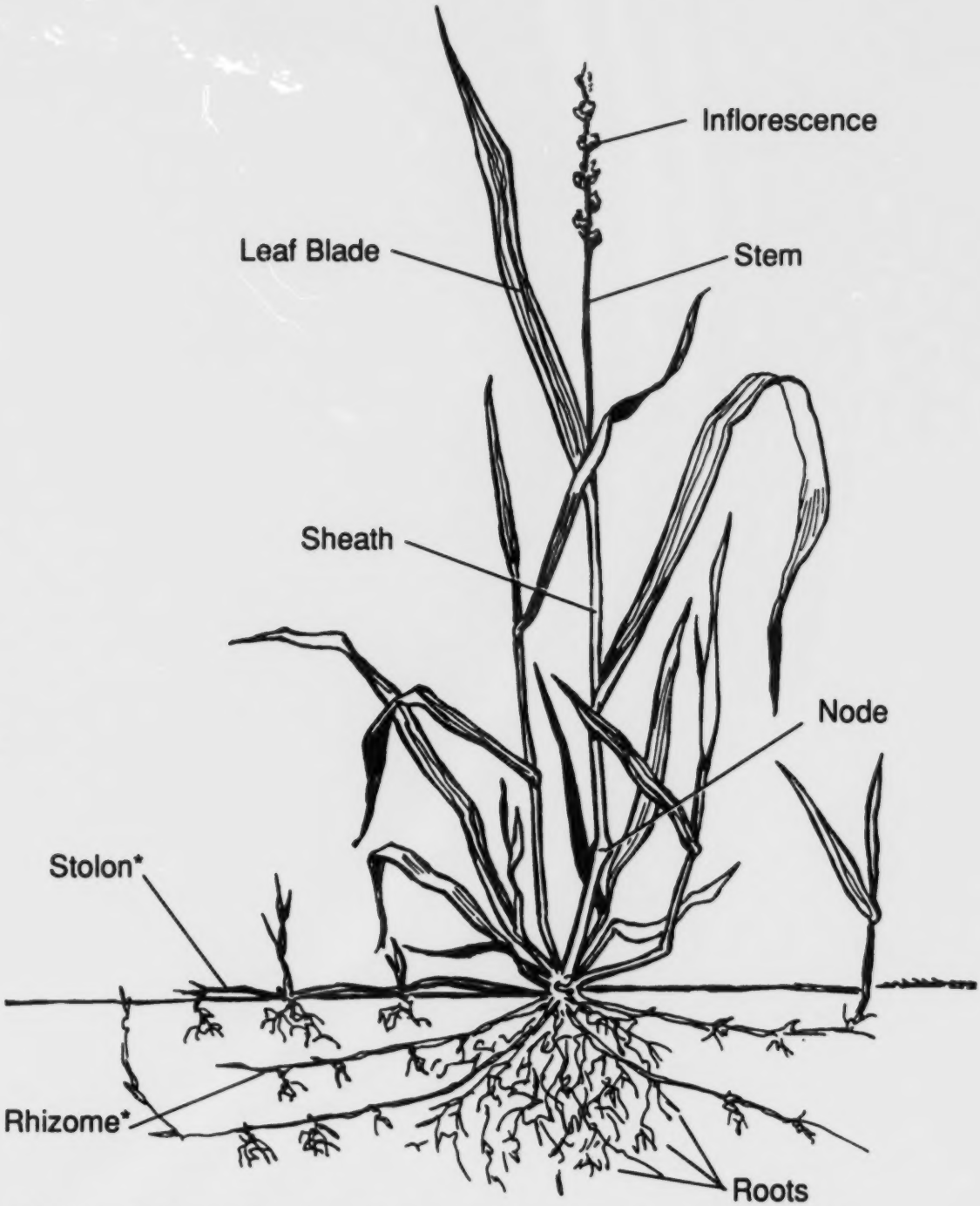
Vegetative parts of most American red clovers are hairy; most European clovers are smooth.

Birdsfoot Trefoil



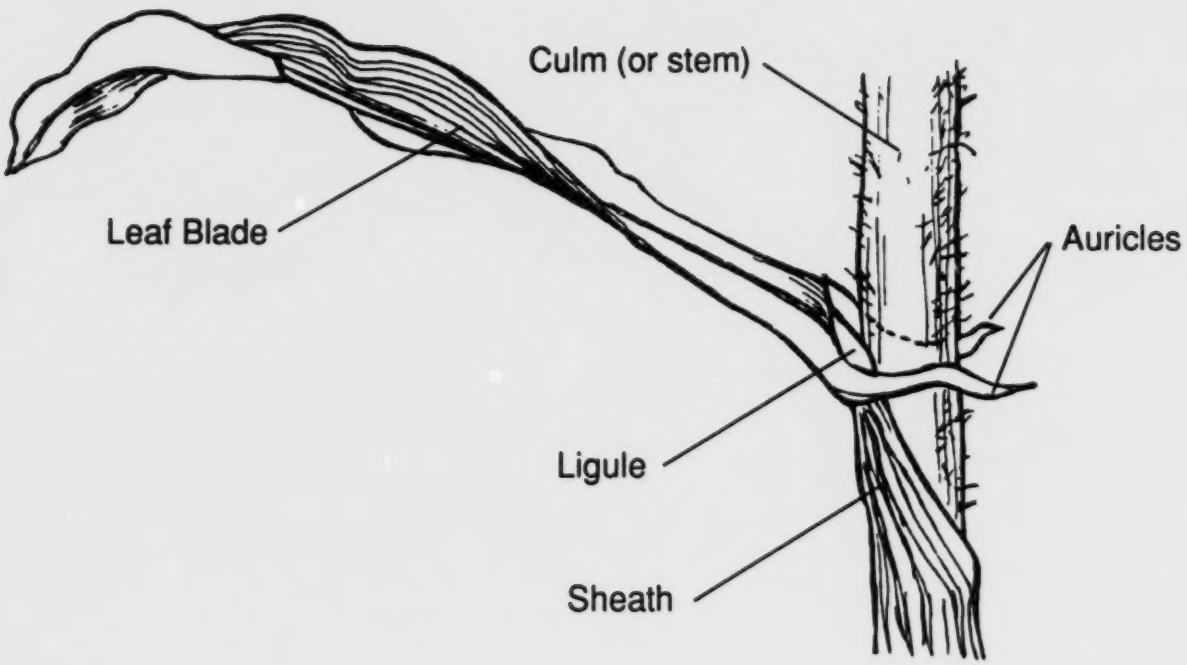
Hairy Vetch

Parts of a Grass Plant



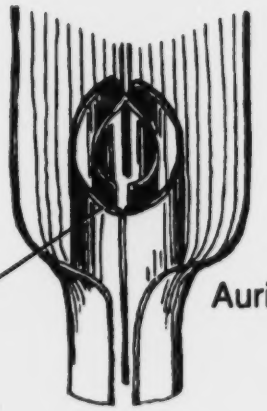
*NOTE: Stolens and Rhizomes are not present on a single plant.

Parts of a Grass Leaf



Leaf Characteristics of Three Grass Species

Kentucky Blue Grass



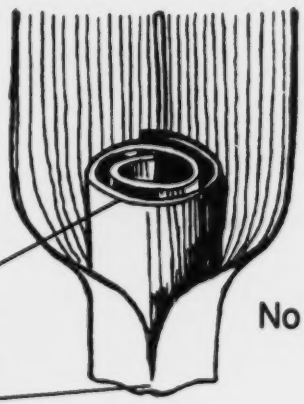
Leaf Blade

V-shaped X section

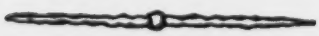
Bud shoot showing leaves folded

Auricles absent

Smooth Bromegrass



Leaf Blade



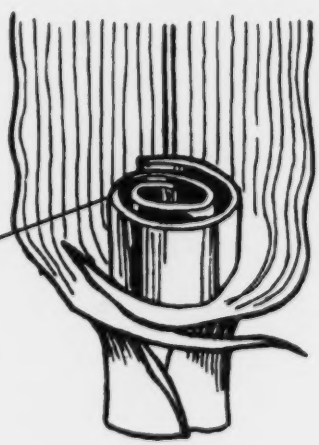
Flat in X section

Leaves rolled in bud shoot

No auricles

Sheath closed (appears as if "welded" together)

Quackgrass



Leaf Blade

Flat in X section

Leaves rolled in bud sheet

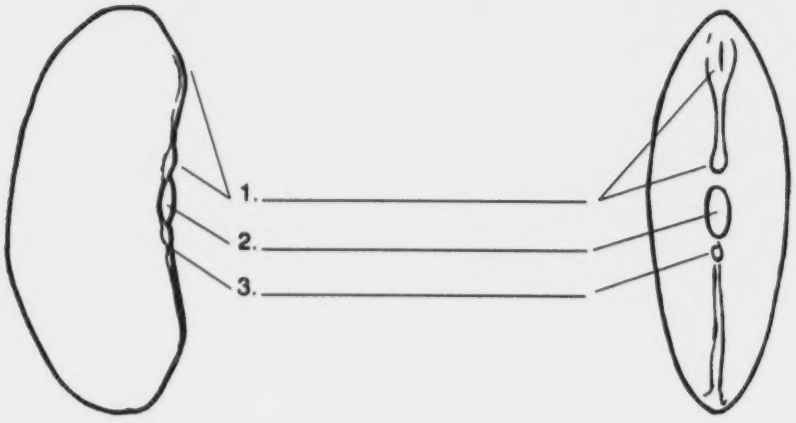
Claw-like auricles

Lesson 3: Plant and Seed Identification Name_____

PARTS OF A BEAN SEED

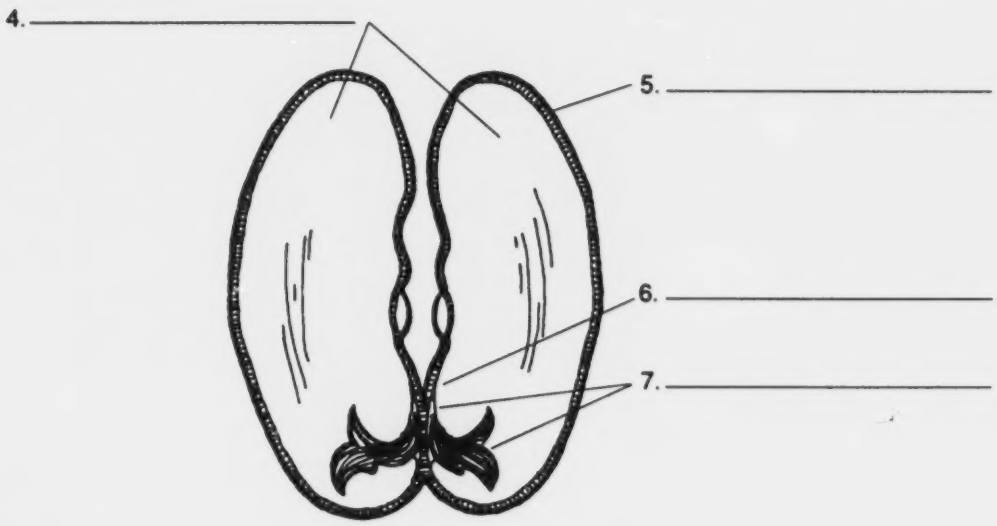
Place in the appropriate space the correct part.

A Bean Seed

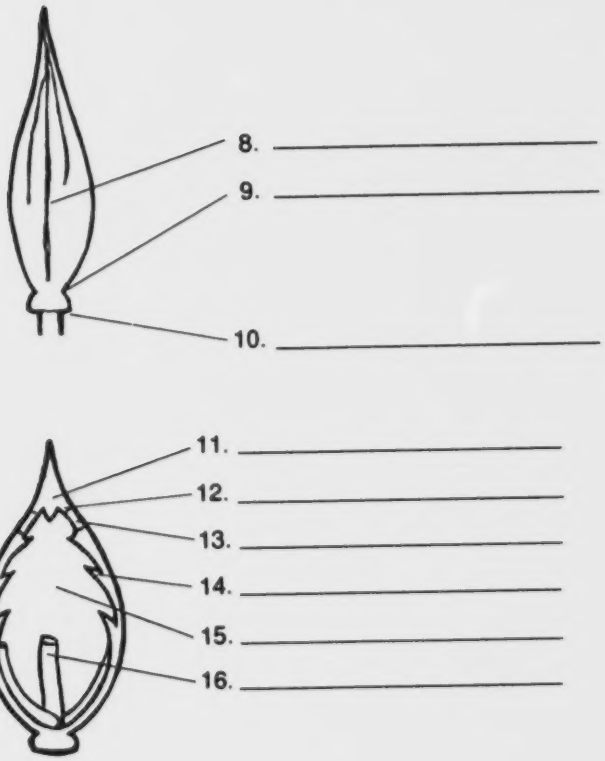


Parts

a. Seed coat
b. Radicle
c. Cotyledons
d. Raphe
e. Shoot
f. Hilum
g. Micropyle



A Cereal Grain



Parts

a. Awn

b. Mid Vein

c. Apex of Palea

d. Callus

e. Lemma

f. Suture

g. Palea

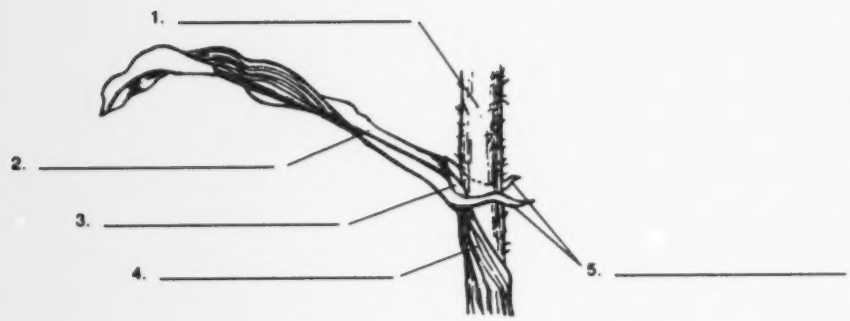
h. Rachilla

i. Teeth of edge of palea (keel)

Lesson 3: Plant and Seed Identification Name _____

PARTS OF A GRASS PLANT AND LEAF

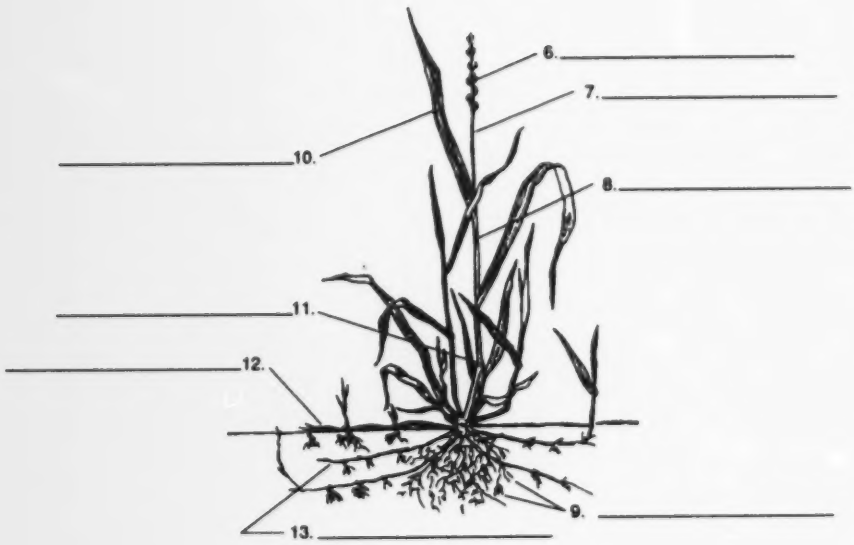
A Grass Leaf



Parts

a. Culm
b. Ligule
c. Auricles
d. Sheath
e. Leaf blade

A Grass Plant



Parts

a. Rhizome
b. Sheath
c. Roots
d. Culm
e. Inflorescence
f. Stolon
g. Node
h. Leaf blade

Lesson 3: Plant and Seed Identification Name _____

CHARACTERISTICS OF SELECTED CROP AND WEED PLANTS

Directions: Using the selected plants provided by the instructor and information found in the student reference, fill in the appropriate sections with the correct information describing the characteristics of the selected crop and weed plants.

Plant #1

Common name _____

Life cycle _____

Plant height (mature) _____

Type of leaves _____

Type of stems _____

Type of flowers _____

Type of roots _____

Plant #2

Common name _____

Life cycle _____

Plant height (mature) _____

Type of leaves _____

Type of stems _____

Type of flowers _____

Type of roots _____

Plant #3

Common name _____

Life cycle _____

Plant height (mature) _____

Type of leaves _____

Type of stems _____

Type of flowers _____

Type of roots _____

Plant #4

Common name _____

Life cycle _____

Plant height (mature) _____

Type of leaves _____

Type of stems _____

Type of flowers _____

Type of roots _____

Plant #5

Common name _____

Life cycle _____

Plant height (mature) _____

Type of leaves _____

Type of stems _____

Type of flowers _____

Type of roots _____

Lesson 3: Plant and Seed Identification Name _____

SEED IDENTIFICATION SCORE SHEET

Date	Seed Number	Common Name

Total Correct _____

UNIT - CROP SCIENCE

Lesson 4: Certified Seed and Variety Selection

Objective: The student will be able to identify characteristics of quality seed.

Study Questions

1. **What are the characteristics of quality seed?**
2. **What are the four classes of seed certification?**
3. **What are the requirements for seed certification?**
4. **What are the benefits of using certified seed?**
5. **What factors should be considered in selecting a crop variety?**

References

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.
2. Missouri Handbook of Seed Certification Standards. The Missouri Seed Improvement Association. (Instructor's reference only.)
3. Work Sheet
   a) WS 4.1: Seed Information and Germination Test

UNIT - CROP SCIENCE

Lesson 4: Certified Seed and Variety Selection

TEACHING PROCEDURES

A. Review

Review key points from Lesson 3.

B. Motivation

Use WS 4.1 (Seed Information and Germination Test) to generate interest in the process of seed quality testing and germination rates found on certified seed tags. Students will need to be responsible for their seed germination tests.

C. Assignment

D. Supervised study

E. Discussion

1. In order to ensure an adequate crop stand, quality seed should be used when planting the crop. Crop yields can be affected by the seed used. Agronomists estimate the yields from the use of good seed to be 10 to 20 percent greater than yields resulting from poor quality seed. There are several characteristics of quality seed.

   What are the characteristics of quality seed?

   a) Good genetic potential
   b) Good germination
   c) Proper size and development
   d) Uniformity in size and shape
   e) Absence of seed-borne diseases and insects
   f) Absence of prohibited, noxious, and other weed seeds
   g) Absence of other crop seeds and other varieties
   h) Absence of inert materials

2. The objective of seed certification is to ensure the quality of seed used by farmers. Seed certification also assures the buyer that genetic purity of the variety is maintained. There are four classes of certified seed.

   What are the four classes of seed certification?

   a) Breeder seed - This seed is used to produce foundation seed. Small quantities are produced by commercial seed companies.
   b) Foundation seed - Foundation seed is the parent line for registered seed and/or certified seed. (white tag)
   c) Registered seed - This seed is produced from foundation seed, may be used to produce certified seed or sold directly to farmers. (purple tag)
   d) Certified seed - Certified seed is produced from foundation or registered seed; it is sold directly to farmers. (blue tag)

3. Many states have seed laws that are designed to control the quality of seed sold within the state. Seed associations work to produce quality seed with strict requirements.

   What are the requirements for seed certification?

   a) The seed is grown from registered or foundation seed stock.
   b) The crops produced pass an inspection for mixtures, weeds, and diseases in the field.
   c) The harvested crops attain the standard of quality set by the seed association.

4. Research has shown marked benefits from using certified seed. Although the cost of certified seed may be higher than uncertified seed, the benefits outweigh the cost difference.

   What are the benefits of using certified seed?

   a) Guaranteed to be the variety advertised
   b) Guaranteed minimum germination rate
   c) Guaranteed to meet weed, mechanical injury, disease, and insect contamination standards

5. When selecting a crop variety, there are many factors to consider. Environmental factors such as growing season length, soil type, and annual precipitation are important considerations. However, many of these factors cannot be controlled by the farmer. One factor that the farmer can control is the choice of seed to be used.

   What factors should be considered in selecting a crop variety?

   a) Cost
   b) Adaptability of the variety to local growing conditions.
   c) Yield potential
   d) Purity of variety
   e) Quality of crop (protein content, resistance to lodging)
   f) Disease and insect resistance
   g) Maturity date

F. Other activities

1. Have students run some germination tests on different seed lots/varieties to see if the stated germination rate is met.

2. If possible, visit a certified seed processing operation.

3. Invite a certified seed producer to visit with the class about the production of quality seed.

G. Conclusion

Through the use of certified seed, farmers can be assured that the seed is guaranteed in yield ability, purity, quality, and ability to resist diseases and insects. The first step to ensuring a quality crop is selecting quality seed.

H. Competency

Identify characteristics of quality seed.

I. Answers to Evaluation

1. a
2. b
3. a
4. c
5. d

UNIT - CROP SCIENCE Name _____

Lesson 4: Certified Seed and Variety Selection Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. In addition to being free from disease organisms, insects, and weeds, good seed should be uniform in size and shape.

   a. True
   b. False

2. Why is certified seed superior to uncertified seed?

   a. It is guaranteed to contain inert matter.
   b. It is guaranteed to have varietal purity.
   c. It is guaranteed to have equal germination rate.
   d. It is guaranteed to be of equal cost.

3. What is certified seed produced from?

   a. Foundation seed
   b. Breeder seed
   c. Certified seed
   d. Either a, b, or c

4. What is the color of a "Registered Seed" tag?

   a. White
   b. Blue
   c. Purple
   d. No color

5. What is the purpose of certifying seed?

   a. Keep good tax records on quality seed
   b. Limit the number of seed producers
   c. Keep price controls on seeds produced
   d. Guarantee the quality of seed

Lesson 4: Certified Seed and Variety Selection Name _____

SEED INFORMATION AND GERMINATION TEST

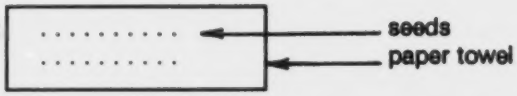
Materials:

1. Tin pie plate
2. 2 paper towels
3. 20 seeds (variety determined by instructor)
4. Information from seed tag
5. Masking tape

Procedure:

1. Transfer information from seed tag onto the table below.
2. Label your pie plate by placing a piece of tape with your name on it on the pie plate.
3. Place one paper towel into the pie plate.
4. Place the 20 seeds in a rectangular pattern on the paper towel in the pie plate.

Example:



5. Place second paper towel over seeds and gently dampen towels until completely damp.
6. Check pan daily (once or twice daily) to ensure that proper moisture is maintained.
7. After five (5) days, check seeds for germination.
8. After 10 days, count the number of seeds germinated. Place in the box titled "% test germination" the percentage that germinated out of the 20 seeds tested.
9. Compare test germination percentage with stated germination percentage.

Note: This activity can be repeated with different varieties.

Crop Variety	Crop Origin	Lot Number	% Purity	% Inert Matter	% of Other Crop Seed	% of Weed Seed	% Stated Germination	% Test Germination

UNIT - CROP SCIENCE

Lesson 5: Stand Establishment

Objective: The student will be able to explain the requirements for establishing a crop stand.

Study Questions

1. **What is the purpose of tillage?**
2. **How do different tillage methods affect the environment?**
3. **Why are different seeding methods used?**
4. **What factors affect the proper depth of planting?**
5. **What major nutrient elements are needed for stand establishment?**
6. **What factors influence the optimum seeding rate?**

Reference

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.

UNIT - CROP SCIENCE

Lesson 5: Stand Establishment

TEACHING PROCEDURES

A. Review

Review key points from Lesson 4.

B. Motivation

Use an ant farm (or view box) to show emergence of seeds. Plant seeds from 1/2 inch to 4 inches deep in 1/2-inch increments. Prepare the demonstration about 7 to 10 days before the anticipated date of presentation to the class.

C. Assignment

D. Supervised study

E. Discussion

1. Proper preparation of a field for planting is vital to the success of the crop. Selecting the appropriate tillage method is dependent on the intended purpose.

   What is the purpose of tillage?

   a) To prepare a suitable seedbed
   b) To eliminate competition from weeds
   c) To improve the physical condition of the soil

2. Soil is a precious natural resource. Each year over 1.6 billion tons of U.S. farm land soil is washed away due to soil erosion. The type of tillage used in crop production influences the amount of soil lost through erosion.

   How do different tillage methods affect the environment?

   a) Conventional tillage leaves the soil surface relatively free of crop residue and vulnerable to erosion.
   b) Minimum tillage methods maintain crop residues on the soil surface and reduce soil erosion.
   c) No-till methods leave all crop residue on the soil surface and nearly eliminate soil erosion.

3. Seeding practices vary, and care must be taken when performing this task to ensure the proper seeding method is used.

   Why are different seeding methods used?

   a) Row method - for planting evenly spaced seeds in parallel rows, allows for mechanical cultivation
   b) Drill method - for planting seeds in narrow rows in high population rates; reduces need for mechanical cultivation

c) Broadcast method - for scattering seeds in a random pattern across the top of the seedbed; does not allow for mechanical weed control; cheapest method; faster coverage for erosion control

4. Several factors should be considered when deciding on the appropriate rate and depth of planting.

What factors affect the proper depth of planting?

a) Type of soil
b) Size of seed
c) Type of emergence
d) Soil moisture
e) Soil temperature

5. After planting, other factors affect the growth and establishment of the crop. Specific nutrients are needed to enable the plants to grow to their potential.

What major nutrient elements are needed for stand establishment?

a) Nitrogen
b) Phosphorus
c) Potassium

6. Proper stand establishment will increase the chances of a good yield; provided the weather is conducive to proper plant growth. The desired plant population is dependent on several factors, one of which is the seeding rate.

What factors influence the optimum seeding rate?

a) Type of crop
b) Use of crop
c) Pure live-seed ratio or percent
d) Seed quality
e) Soil moisture
f) Soil productivity
g) Time of seeding
h) Method of seeding
i) Row width
j) Expected average rainfall

F. Other activities

1. Take a field trip to a local farm to observe the process of seedbed preparation. Discuss the type of tillage used.

2. Arrange for a demonstration of several methods of tillage on the school land laboratory.

3. Conduct experiments with different seeds planted at different depths and calculate emergence time and rates.

G. Conclusion

Proper preparation of the seedbed and planting seed at the proper depth will increase the emergence rate. Tillage during stand establishment can influence the amount of soil lost due to erosion. Tillage, seeding methods, seeding depth, seeding rate, and nutrient availability are factors which greatly influence the crop yields.

H. Competency

Explain the requirements for establishing a crop stand.

I. Answers to Evaluation

1. T
2. F
3. F
4. F
5. T
6. a
7. a
8. c
9. b
10. c
11. a

UNIT - CROP SCIENCE

Name _____

Lesson 5: Stand Establishment

Date _____

EVALUATION

True/False (Place the correct response on the blank provided.)

____ 1. Proper tillage improves seed germination.

____ 2. Conventional tillage methods minimize soil erosion.

____ 3. Conventional tillage results in less soil loss than does minimum tillage.

____ 4. Broadcast seeding involves planting seeds in narrow rows.

____ 5. Seed planting depth should be adjusted according to the soil type and seed size.

Select the tillage method on the right that corresponds best with the statement on the left. Answers may be used more than once.

____ 6. Leaves the soil smooth

____ 7. Uses the moldboard plow, disk, and harrow to prepare

____ 8. Plant seeds directly into previous crop's residue

____ 9. Soil to seed contact is increased while decreasing soil erosion

____ 10. Requires good management practices to control insects and diseases from previous crop

____ 11. Requires more trips across the field

a - Conventional
b - Minimum till
c - No-till

UNIT - CROP SCIENCE

Lesson 6: Managing the Crop

Objective: The student will be able to describe good crop production practices.

Study Questions

1. **What three nutrient elements are applied to most crops?**
2. **When can fertilizer be applied?**
3. **Why is soil pH important in crop production?**
4. **How can soil pH be altered?**
5. **How should plant residues be managed?**
6. **How can plant pests be controlled?**
7. **What irrigation methods are used in crop production?**

Reference

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.

UNIT - CROP SCIENCE

Lesson 6: Managing the Crop

TEACHING PROCEDURES

A. Review

Review key points from Lesson 5.

B. Motivation

Ask students what the term "management decisions" means to them. Briefly discuss the effects of good and poor decisions on crop production. Describe how crop yields have changed over the past century due to commercial fertilizers, hybrid seeds, and other technological advances.

C. Assignment

D. Supervised study

E. Discussion

1. In order for plants to grow properly and produce good yields, they need to have essential nutrient elements for proper growth and development. Ask students to identify the kinds of fertilizers and the amount that should be applied to locally grown crops.

   What three nutrient elements are applied to most crops?

   a) Nitrogen (N)
   b) Phosphorus (P)
   c) Potassium (K)

2. The most common method of maintaining adequate levels of essential nutrients in the soil is through the application of commercial fertilizers. After a soil test is taken, analyzed and recommendations are made, appropriate amounts and grades of fertilizers can be applied.

   When can fertilizer be applied?

   a) At planting time, starter fertilizer
   b) After plants have emerged from soil, side dressing
   c) After plants are established, top dressing

3. Optimum plant growth is dependent on the presence of essential nutrient elements. Optimum plant growth also depends on the degree of acidity or alkalinity of the soil, commonly referred to as soil pH. Extremely acid or alkaline soils reduce crop yields. Crop production is usually maximized when soil pH is near neutral or slightly acidic.

   Why is soil pH important in crop production?

   a) Crops grow and produce the best within a pH range of 5.0 to 7.5.
   b) Soil pH affects the availability of nutrients for plant uptake.

4. Soil nutrient deficiencies can be corrected through application of fertilizers. Soil pH can also be adjusted to improve plant growth.

   How can soil pH be altered?

   a) Application of lime reduces soil acidity
   b) Application of sulfur or aluminum sulfate will reduce soil alkalinity

5. Once a crop is harvested, the producer is left with the decision of what to do with the plant residue left on the field. Plant residue can be beneficial in several ways depending on how it is managed. Sometimes plant residues are also removed for use as animal feed or bedding.

   How should plant residues be managed?

   a) Mixed/tilled into the soil to provide organic matter
   b) Left on the field surface to reduce soil erosion due to wind and water

6. Pest control in crop production is important. Crop pests cost producers billions of dollars annually. Control measures should be taken to reduce the damage caused by crop pests.

   How can plant pests be controlled?

   a) Mechanical pest control
   b) Cultural pest control
   c) Biological pest control
   d) Genetic pest control
   e) Chemical pest control

7. In many states, rainfall may be inadequate to reach a crop's potential yield. Water is vital for plant growth. Irrigation is a mechanical technique of supplying water to plants. Farmers use specialized techniques of irrigation to supply water for growing crops.

   What irrigation methods are used in crop production?

   a) Aerial sprinkler systems (center pivot)
   b) Surface (flood, drip, furrow)

F. Other activities

1. Using several examples of fertilizer bags (different grades), demonstrate to the students how to calculate the amount of nutrients in each bag.

2. Demonstrate or have students demonstrate a soil pH test. Then, demonstrate how to alter the soil with agricultural lime, sulfur, or aluminum sulfate as needed.

G. Conclusion

Proper crop management involves taking a soil test to analyze and determine the nutrient needs and pH of the soil. Once these facts are known, more informed management decisions can be made. Decisions that involve pest control measures and the use of irrigation depend on factors such as the crop grown, geographical location, and soil type.

H. Competency

Describe good crop production practices.

I. Answers to Evaluation

1. F
2. T
3. F
4. T
5. a
6. b
7. b
8. c

UNIT - CROP SCIENCE Name _____

Lesson 6: Managing the Crop Date _____

EVALUATION

True/False (Place the correct response in the blank provided.)

____ 1. A complete fertilizer contains nitrogen, phosphorus, and manganese.

____ 2. Taking a soil test is a good management practice.

____ 3. Pest control has little impact on crop yields.

____ 4. Most crop plants grow best between pH 5.0 and 7.5.

Circle the letter that corresponds to the best answer.

5. In order to reduce soil acidity, _____.

   a. Lime should be applied
   b. Sulfur should be applied
   c. Aluminum sulfate should be applied
   d. Crop residue should be plowed under

6. In order to reduce soil alkalinity, _____.

   a. Lime should be applied
   b. Sulfur should be applied
   c. Crop residue should be plowed under
   d. Crop residue should be left on soil surface

7. Soil erosion can <u>best</u> be controlled by _____.

   a. Plowing all the plant residue into the soil
   b. Leaving all the plant residue on the soil surface
   c. Liming the soil before planting
   d. Adding animal manure to the soil

8. Furrow irrigation is a form of _____.

   a. Pivot irrigation
   b. Aerial irrigation
   c. Surface irrigation
   d. Sprinkler irrigation

UNIT - CROP SCIENCE

Lesson 7: Harvesting and Storing Grains

Objective: The student will be able to explain factors related to harvesting and storing quality grain.

Study Questions

1. **What factors determine the proper time to harvest grain crops?**
2. **What factors are used in federal grain grading?**
3. **What are the factors that affect grain quality?**
4. **What methods are used to harvest grain crops?**
5. **What factors affect the quality of stored grains?**
6. **How can crop quality be maintained during harvest and storage?**
7. **What are the methods of drying grain?**

Reference

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.

UNIT - CROP SCIENCE

Lesson 7: Harvesting and Storing Grains

TEACHING PROCEDURES

A. Review

Review key points of Lesson 6.

B. Motivation

Collect several samples of commonly stored grain (e.g., corn, wheat, and soybeans). Display them in small glass jars. Take one of the samples and add additional moisture to the jar to stimulate heat and mold damage. (This should be done in advance of the unit to produce mold.) Use this for discussion.

C. Assignment

D. Supervised study

E. Discussion

1. It is important to harvest a crop at the optimum time in order to ensure the greatest yield and highest quality.

   What factors determine the proper time to harvest grain crops?

   a) Plant characteristics
      1) Stage of maturity
      2) Tendency to lodge
      3) Tendency to shatter
   b) Climatic factors
      1) Rainfall
      2) Humidity
      3) Temperature
   c) Harvesting methods

2. Grain quality is important to both the producer and the purchaser. To the producer, a better quality grade for the crop can mean a higher return for the investment. For the purchaser, grain quality is important to ensure that the grain can be processed into consumer products.

   What factors are used in federal grain grading?

   a) Class
   b) Test weight per bushel
   c) Percentage of damaged kernels
   d) Percentage of foreign material
   e) Percentage of other classes

3. Grading agricultural products requires special skills. Grain quality is influenced by several factors.

What are the factors that affect grain quality?

a) Purity of crop and variety
b) Percentage of weeds and other mixtures
c) Percentage of diseased and damaged kernels

4. Harvesting the grain crop is an important step in the process of grain production. The decision of which harvesting method to use is important.

What methods are used to harvest grain crops?

a) Direct combine method
b) Windrow-pickup combine method

5. The potential for profit from high yielding crops can be decreased if the grain is improperly stored. When storing grain, consideration should be given to those factors that affect grain spoilage and deterioration.

What factors affect the quality of stored grain?

a) High moisture content
b) Heat damage
c) Rotting
d) Improper drying (too dry, too wet)
e) Foreign material present
f) Insect and rodent infestation

6. Steps to prevent stored grain deterioration should be taken in advance in order to prevent problems.

How can crop quality be maintained during harvest and storage?

a) Harvest grain at proper moisture content
b) Properly construct and maintain storage bins
c) Protect against pests (insects, rodents, birds)
d) Provide proper ventilation
e) Secure from fire and wind damage
f) Inspect grain frequently

7. Ask students to give reasons for drying grain on the farm (reduce machine and field losses through early harvest; improved market price by more timely marketing; better market grade; reduced storage losses, etc.). Then, discuss the methods of drying stored grain.

What are the methods of drying grain?

a) Drying with forced, unheated air
b) Drying with forced, heated air
c) Field drying

F. Other activities

1. Take a field trip to a farm or local grain elevator and have students observe facilities used to dry and store grain crops.

2. Visit a grain harvesting operation and allow students to observe the process.

G. Conclusion

Harvesting and storing quality grain involves harvesting in a timely manner, using appropriate methods for harvesting and storage, and maintaining stored grain to prevent losses due to spoilage.

H. Competency

Explain factors related to harvesting and storing quality grain.

I. Answers to Evaluation

1. T
2. T
3. F
4. F
5. T
6. a
7. c
8. b
9. c

UNIT - CROP SCIENCE

Name _____

Lesson 7: Harvesting and Storing Grains

Date _____

EVALUATION

True/False (Place the correct response in the blank provided.)

____ 1. Premature harvesting usually results in smaller yields and reduction in quality.

____ 2. The percentage of moisture in the grain varies with the stage of maturity.

____ 3. Wheat is usually harvested by direct combining when the grain moisture is above 16 percent.

____ 4. Direct combining works best when the crop ripens unevenly and the grain moisture is low.

____ 5. Excessive moisture usually results in the deterioration of stored grain caused by mold growth and heat damage.

Circle the letter that corresponds to the best answer.

6. Drying grain with unheated air should be used when grain moisture content is no more than _____.

   a. 15 percent moisture
   b. 30 percent moisture
   c. 45 percent moisture
   d. 60 percent moisture

7. For final drying, unheated air should contain less than _____.

   a. 10-15 percent humidity
   b. 20-25 percent humidity
   c. 50-60 percent humidity
   d. 80-90 percent humidity

8. One benefit of drying with unheated air is _____.

   a. Discounts on fuel costs
   b. Lower initial equipment costs
   c. Increased supervision
   d. Overdrying

9. What is one disadvantage of drying grain with heated air?

   a. Wetter grain can be dried
   b. Less time is required to dry grain
   c. More supervision is needed
   d. Weather conditions have little effect on drying time

UNIT - CROP SCIENCE

Lesson 8: Harvesting and Storing Forages

Objective: The student will be able to describe factors related to harvesting and storing quality forage.

Study Questions

1. **What factors determine the appropriate time to harvest forages?**
2. **How is forage quality determined?**
3. **When should forages be harvested?**
4. **What methods are used to harvest forages?**
5. **What causes the quality of forages to deteriorate?**
6. **How can forage deterioration be prevented?**
7. **What are the basic storage requirements of forages?**
8. **What are the ways to improve field drying?**

References

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.
2. Transparency Master
   a) TM 8.1: Yield and Quality In Forages

UNIT - CROP SCIENCE

Lesson 8: Harvesting and Storing Forages

TEACHING PROCEDURES

A. Review

Review grain harvesting times, methods, and storage concerns as discussed in Lesson 7.

B. Motivation

Bring in several samples of forages. Have students inspect and identify them. Discuss the harvesting and storage methods used with each sample.

C. Assignment

D. Supervised study

E. Discussion

1. As plants mature, yield increases but quality decreases. Selecting the appropriate time to harvest is an important factor influencing crop quality. In order to ensure high quality forages, harvesting must be completed at the appropriate time. Use TM 8.1.

   What factors determine the appropriate time to harvest forages?

   a) Balance between quality and yield (appropriate time)
   b) Weather conditions - avoid rain, which leaches nutrients from cut forages

2. The quality of hay or silage is directly related to the level of milk production in dairy cattle and rate of gain in livestock production. Producing and harvesting quality forages is important to enable farmers to provide quality feed to livestock.

   How is forage quality determined?

   a) Physical appearance
      1) Visual appearance
         (a) Leafy
         (b) Fine texture
         (c) No foreign material
      2) Color (bright green)
      3) Odor (pleasant)
   b) Chemical analysis
      1) Crude protein content
      2) Fiber content
      3) Digestibility
      4) Lignin content

3. In order to store and feed hay, silage, or haylage of high quality, the forage crop must be of quality. Harvesting must be done at the appropriate time to produce a quality feed product.

   When should forages be harvested?

a) Harvest before the crop is fully mature
   1) Alfalfa - first flower to 1/10 bloom
   2) Alsike clover - 1/2 to full bloom
   3) Bird's-foot trefoil - 1/10 bloom
   4) Cowpeas - when first pods have started to ripen
   5) Corn silage - harvest when kernels are fully dented and glazed
   6) Crimson clover - 1/2 bloom
   7) Fescue - boot to early heading
   8) Ladino clover - full bloom
   9) Lespedeza - early bloom
   10) Medium red clover - 1/4 to 1/2 bloom
   11) Small grains - boot stage to early dough stage
   12) Soybeans - when beans in the pod are half developed
   13) Sweet clover - when first blossoms appear
   14) Brome grass - early bloom (anthesis)
   15) Orchard grass - fully headed but before bloom
   16) Reed canary grass - when first heads appear
   17) Timothy - early bloom (anthesis)

4. Mechanization has improved forage harvesting and handling. Forage harvesting methods vary depending upon how the forage will be stored and used.

What methods are used to harvest forages?

a) Grazing
b) Dry hay systems
   1) Conventional bales
   2) Large round bales
   3) Large rectangular bales
   4) Portable haystack
   5) Field cubes
c) High moisture systems
   1) Green chopped
   2) Haylage (40% - 60%)
   3) Silage (60% - 70%)
d) Special forage processing systems
   1) Stationary cubers
   2) Pelleting machines

5. Forage deterioration can be a costly problem. Deterioration of forages decreases quality and profit. Deterioration in some forage crops can be harmful to animal health.

What causes the quality of forages to deteriorate?

a) Improper harvest time (early or late)
b) Improper baling time (wet or too dry)
c) Improper harvesting methods
d) Improper storage

6. Forages provide an excellent source of nutrients to livestock. If deterioration of forages is permitted, the feed value decreases. Measures to prevent forage deterioration should be taken in order to ensure quality.

How can forage deterioration be prevented?

a) Harvest at proper time
b) Use proper harvest methods
c) Ensure proper moisture content at harvest
d) Maintain proper storage facilities

7. Proper storage techniques are just as important to forages as to grains. If storage is improper, deterioration of forages due to mold, heat damage, rotting and spoilage will occur.

What are the basic storage requirements of forages?

a) Dry hay
    1) Protection from weather
    2) Protection from insects, animals, and birds
    3) Adequate ventilation
b) Silage and haylage
    1) Protection from weather
    2) Protection from insects, animals, and birds
    3) Air tight facility
    4) Provisions for proper filling, emptying, monitoring, and cleaning

8. Most forage crop deterioration is caused by excessive moisture content, which leads to reduction in quality, heat damage, and molding. Methods of drying forages can reduce moisture levels, improve storage, and ensure quality.

What are the ways to improve field drying?

a) Swath drying
b) Windrow drying
c) Crushing or conditioning
d) Chemical additives

F. Other activities

1. Take a class field trip to a local farm to observe a forage harvesting operation (e.g., cutting, baling, or storing).

2. Display samples of several grades of forages that have been baled. Discuss the quality (e.g., color, odor, leafiness, and stems) of each.

3. Display a bale that was baled at too high a moisture content. Break open the bale and discuss the molding and heat damage along with the possible hazard from fires caused by improperly stored hay.

G. Conclusion

Forage crops are vital feedstuffs for livestock and dairy operations in the U.S. Quality forages are an excellent source of essential nutrients that increase weight gain in livestock and milk production in dairy cattle. Harvest time, method of harvesting, and proper storage all are important factors in producing quality forages.

H. Competency

Describe factors related to harvesting and storing quality forage.

I. Answers to Evaluation

1. T
2. T
3. F
4. F
5. F
6. c
7. d
8. c
9. b
10. d

UNIT - CROP SCIENCE Name _____

Lesson 8: Harvesting and Storing Forages Date _____

EVALUATION

True/False (Place the correct response in the blank provided.)

____ 1. Proper harvesting time is important to ensure the quality of a forage.

____ 2. Soybeans can be considered a forage crop.

____ 3. Nutrient value and palatability increase once the forage passes the optimum harvest point.

____ 4. Weather conditions are <u>not</u> a consideration during harvest.

____ 5. Chemical analysis is the <u>most common</u> method of determining forage quality.

Circle the letter that corresponds to the best answer.

6. Shattering is a result of _____.

   a. Early harvest
   b. High moisture content
   c. Late harvest
   d. Improper storage

7. Lodging is a result of _____.

   a. High moisture content
   b. Improper storage
   c. Early harvest
   d. Delayed harvest

8. What is the moisture content of silage?

   a. 25-30%
   b. 40-60%
   c. 60-75%
   d. 80-95%

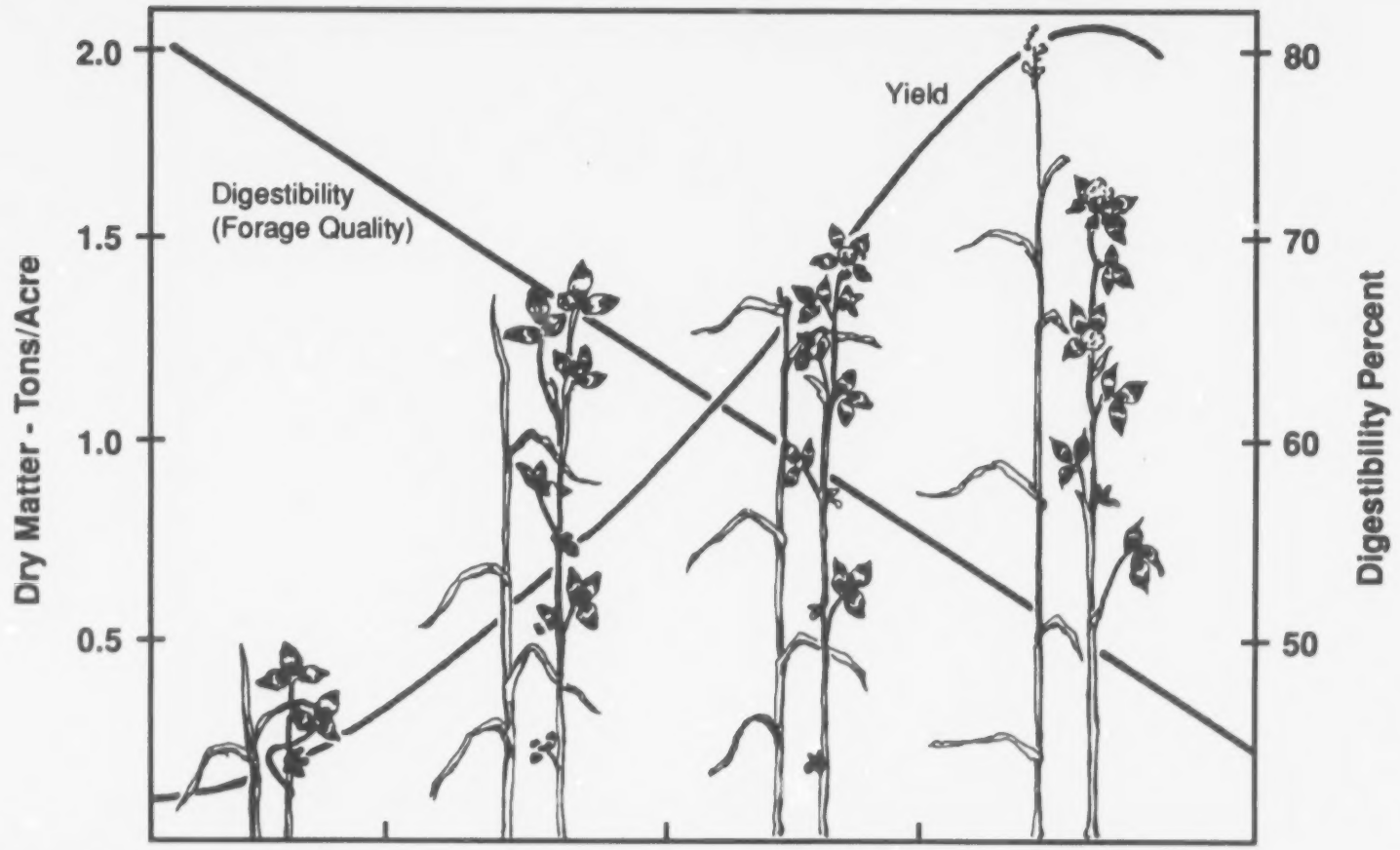
9. What is the moisture content of haylage?

   a. 25-30%
   b. 40-60%
   c. 60-75%
   d. 80-95%

10. Leaching of nutrients from forages is caused by _____.

a. Overdrying in the sun
b. Improper storage
c. Early cutting
d. Rain damage

Yield and Quality in Forages



UNIT - CROP SCIENCE

Lesson 9: Controlling Crop Pests

Objective: The student will be able to describe methods of plant pest control.

Study Questions

1. **What types of pests affect plant growth?**
2. **What methods are used to control weeds?**
3. **What methods are used to control insects?**
4. **What methods are used to control plant diseases?**
5. **How can pesticides be handled and applied safely?**
6. **How is "integrated pest management" used in agriculture?**

Reference

1. Crop Science (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.

UNIT - CROP SCIENCE

Lesson 9: Controlling Crop Pests

TEACHING PROCEDURES

A. Review

Review key points from Lesson 8.

B. Motivation

Locate some flour that is infested with weevils. Have the class inspect the flour. Ask them if they would like to eat cake or bread made from this flour. Point out the weevils and describe the problem of crop insects in the U.S.

C. Assignment

D. Supervised study

E. Discussion

1. Crop producers must continually work to control plant pests. Damage to crops from pests is a major problem in the U.S. However, many developing countries have very low levels of production due to competition from plant pests.

   What types of pests affect plant growth?

   a) Weeds
   b) Insects
   c) Plant diseases

2. Weeds cause considerable damage and loss to crops annually. Crop growth can be hindered because of weeds. Crop quality can also be reduced by weed seeds in the crop at harvest.

   What methods are used to control weeds?

   a) Hand
   b) Mechanical cultivation
   c) Chemical methods
   d) Biological methods

3. Insects continue to challenge crop producers and scientists to find new ways to control them and the damage they cause.

   What methods are used to control insects?

   a) Genetic
   b) Cultural
   c) Biological
   d) Chemical

4. Prevention of plant diseases is preferable to trying to cure it after it has begun.

What methods are used to control plant diseases?

a) Genetic (disease-resistant varieties)
b) Cultural (crop rotation, cultivation methods)
c) Chemical (fungicides, etc.)
d) Isolation (quarantine stations, etc.)

5. In 1988, over 820 million pounds of pesticides were used at a cost of over six billion dollars in the U.S. Pesticides are toxic to crop pests, but may also be hazardous to humans and other animals. Pesticides should be handled and applied safely.

How can pesticides be handled and applied safely?

a) Be properly trained in pesticide application
b) Read and follow pesticide label directions
c) Understand the toxicity ratings, signal words, and symbols
d) Wear protective clothing and use protective equipment
e) Provide proper storage

6. Pest management is a concern of every crop producer. A great deal of research has gone into developing methods of pest control. Concern for the environment and the effects of chemicals on food products have prompted producers and researchers to work at developing different strategies to control crop pests. IPM (integrated pest management) is one of those strategies.

How is "integrated pest management" used in agriculture?

Integrated pest management (IPM) uses multiple techniques of pest control once economic thresholds have been established.

F. Other activities

1. Have students compile a list of pesticides they have at home and record the label information.

2. Have a commercial pesticide applicator speak to the class on safety procedures.

3. Have students select a crop pest from a teacher-generated list and research the pest's life cycle, crops affected, control methods, etc.

4. Collect and mount specimens of crop pests (e.g., weeds and insects), which can be used for future study and reference.

G. Conclusion

Preventing crop pests is more efficient than trying to get rid of them after they become a problem. Methods used to control crop pests include the safe use of pesticides, good cultural practices, and the incorporation of integrated pest management strategies.

H. Competency

Describe methods of plant pest control.

I. Answers to Evaluation

1. F
2. T
3. F
4. F
5. T
6. T
7. d
8. c
9. a
10. b

UNIT - CROP SCIENCE Name _____

Lesson 9: Controlling Crop Pests Date _____

EVALUATION

True/False (Place the correct response in the blank provided.)

____ 1. Crop pests include all species of insects.

____ 2. Preventing crop pests is more efficient than controlling pests once they appear.

____ 3. Mechanical methods can be used to control diseases in a growing crop.

____ 4. Genetic pest control involves the use of chemicals.

____ 5. Integrated Pest Management incorporates multiple control techniques.

____ 6. Pesticides should never be transferred to glass food jars for storage.

Match the management practice with the type of control.

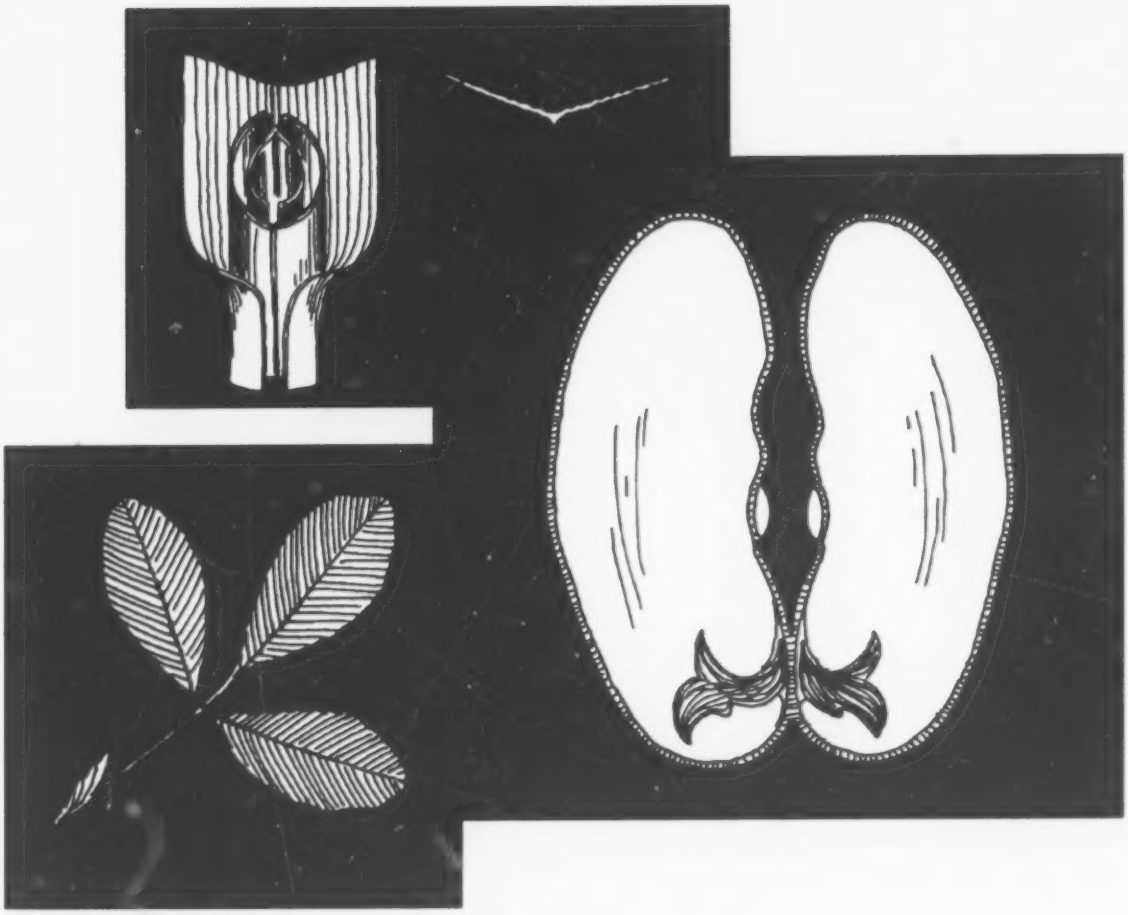
Management Practice		Type of Control	
____ 7.	Crop rotation	a.	Genetic
____ 8.	Using predator insects	b.	Chemical
____ 9.	Using pest-resistant cultivars	c.	Biological
____ 10.	Aerial dusting of crops	d.	Cultural

10-1035-S

MISSOURI AGRICULTURAL EDUCATION

Student Reference

Crop Science



In cooperation with Agricultural Education
Department of Practical Arts and
Vocational-Technical Education
College of Education and
College of Agriculture, Food and Natural Resources
University of Missouri - Columbia

In cooperation with
Agricultural Education Section
Division of Vocational and Adult Education
Department of
Elementary and Secondary Education
Jefferson City, Missouri

BEST COPY AVAILABLE

Available from:
Instructional Materials Laboratory
University of Missouri-Columbia
10 London Hall
Columbia, MO 65211
314-882-2883

The activity which is the subject of this report was supported in whole or in part by funds from the Department of Elementary and Secondary Education, Division of Vocational and Adult Education. However, the opinions expressed herein do not necessarily reflect the position or policies of the Missouri Department of Elementary and Secondary Education or the Division of Vocational and Adult Education, and no official endorsement should be inferred.

Student Reference

CROP SCIENCE

Writer:
John Kevin Humphrey
Instructional Materials Laboratory
University of Missouri-Columbia

Consulting Editor:
Robert J. Birkenholz
Agricultural Education
University of Missouri-Columbia

Editor and Project Coordinator:
Veronica Feilner
Instructional Materials Laboratory
University of Missouri-Columbia

Available from:
Instructional Materials Laboratory
University of Missouri-Columbia
10 London Hall
Columbia, Missouri 65211

Volume 24
Number 6

Catalog Number 10-1035-S
January 1992

ACKNOWLEDGMENTS

Recognition is given to advisory committee members for providing their valuable time and suggestions in developing this crop science unit. The committee consisted of Matt Biddle, Bob Buehler, Dan Forster, Steven King, Delbert Lund, Richard Mattas, Bob McGraw, Charles Parkes, Bill Roberts, Brenda Smith, and Jim Welker.

Appreciation is expressed to the following staff members of the Instructional Materials Laboratory for their efforts in producing this material: Harley Schlichting, Director; Amon Herd, Associate Director; Phyllis Miller, Assistant Director; Dan Stapleton, Assistant Director; Sharon Dyer, Graphic Designer; Lori Holliday and Tracy Stock, Word Processors; and Wei Li, Graduate Assistant.

Veronica Feilner, Editor and Project Coordinator
Instructional Materials Laboratory
University of Missouri-Columbia

Robert R. Birkenholz, Assoc. Professor
Agricultural Education
University of Missouri-Columbia

FOREWORD

The development of the Crop Science unit is the result of suggestions by the MVATA Teaching Aids Committee. The Plant and Crop Science Advisory Committee suggested the topics to be included and reviewed the materials.

This student reference contains nine lessons: Economic Importance of Crops; Crop Uses (Products and By-Products); Plant and Seed Identification; Certified Seed and Variety Selection; Stand Establishment; Managing the Crop; Harvesting and Storing Grains; Harvesting and Storing Forages; and Controlling Crop Pests. See the Table of Contents for a detailed listing of topics.

Persons using this reference on an individual basis may wish to purchase the instructor's guide, which contains additional reference materials.

Bob R. Stewart, Professor and Coordinator
Agricultural Education
University of Missouri-Columbia

Terry Heiman, Director
Agricultural Education
Department of Elementary and
Secondary Education

TABLE OF CONTENTS

ACKNOWLEDGMENTS ii

FOREWORD iii

Lesson 1--Economic Importance of Crops 1
- Major Crops of Missouri
- Missouri and the Nation
- Major World Crops
- Which Crops to Grow
- International Relationships
- Effects of Foreign Crop Production on the U.S.
- Crop Production and Society Development

Lesson 2--Crop Uses (Products and By-Products) 4
- Major Uses of Crops
- Major Crops
- Products from Corn
- Products from Soybeans
- Determining Plant Use

Lesson 3--Plant and Seed Identification 7
- Seed Identification
- Weed Classes
- Plant Identification

Lesson 4--Certified Seed and Variety Selection 24
- Quality Seed Characteristics
- Seed Certification
- Requirements for Seed Certification
- Benefits of Certified Seed
- Crop Variety Selection

Lesson 5--Stand Establishment 29
- Tillage
- Tillage and the Environment
- Seeding
- Seed Depth and Fertilization
- Seeding Rates

Lesson 6--Managing the Crop 32
- Elements Needed for Plant Growth Application
- Soil pH
- Crop Residues
- Pest Control
- Irrigation

Lesson 7--Harvesting and Storing Grains 35
- Harvest Time
- Grading Grains
- Grain Quality Factors
- Methods of Harvesting
- Improperly Stored Grain
- Maintaining Crop Quality
- Drying Grain

Lesson 8--Harvesting and Storing Forages 39
Determining Harvest Time
Determining Forage Quality
When to Harvest Forages
Methods of Harvest
Forage Deterioration
Storage Requirements
Improving Field Drying
Lesson 9--Controlling Crop Pests 43
Pests
Weed Control
Insect Control
Disease Control
Pesticide Safety
Integrated Pest Management

Lesson 1:
Economic Importance of Crops

The strength and independence of the U.S. is in part the result of the efforts and accomplishments of the American farmer. Efficient production in the U.S. enables people to work in other occupations while a small proportion of workers devote their efforts to producing food. The production of food has been and will continue to be of primary importance. Agriculture in the U.S. and the world will continue to be a key point of concern when nations discuss economics and world trade.

Major Crops of Missouri

The diverse geography of Missouri provides a wide range of opportunities for agricultural use. The land, soil type, climate, and available water promote the diversity of agriculture throughout the state. Because of the uniqueness of Missouri land and natural resources, the state is able to produce a variety of crops. Major crops produced in Missouri are soybeans, corn, wheat, cotton, rice, hay, grain sorghum, fescue seed, and lespedeza.

Missouri and the Nation

The production of agricultural products plays a key role in the economy of the state of Missouri. Each year, Missouri agriculture generates over $15 billion in marketings. Because of the state's agricultural diversity, Missouri is able to export many agricultural products to other countries.

Many other states in the U.S. also produce crops for export overseas. However, Missouri ranks among the top 10 states in the production of several crops. Missouri ranks as follows: 2nd in hay production excluding alfalfa, 4th in sorghum production, 4th in winter wheat, 6th in soybeans, 6th in rice, 6th in concord grapes, 9th in corn production for grain, and 10th in cotton.

Major World Crops

The U.S. is the top producer and exporter of agricultural products in the world. Other countries have increased crop production levels so they can provide more food and participate in world trade. Major crops are grouped by their use: cereal grains, oilseeds, sugar, and fiber crops. The major crops in these categories are listed below:

1. Cereal grains - wheat, barley, oats, rye, corn, sorghum, rice
2. Oilseeds - cotton, soybeans, peanuts, canola, rapeseed, sunflower, safflower
3. Sugar - sugar beets, sugar cane
4. Fiber crops - cotton, hemp, flax, jute

Which Crops to Grow

Many factors that affect plant growth should be considered when deciding what crops to grow. The U.S. has abundant fertile land (land that is fit for cultivation) and a relatively mild climate. However, there are many factors that affect which crops are grown: land capability and use, climate, resource availability, product demand, and international trade.

Land capability and use refers to what the land is capable of producing within its limitations. Not all land is the same. Many characteristics are different, and when considering land for agricultural use, recognizing limitations is important. Land capability also refers to the most appropriate use of land. Some land, because of its slope or soil type, should be restricted from row crop production. Other land may be less subject to erosion and therefore, may be used for row crop production.

Climate is another factor that must be considered when deciding on which crop to grow. All aspects of climate affect agricultural production and development. Surface and subsoil temperatures are critical to plant and microorganism growth. Some crop plant varieties are adapted to cooler temperatures and shorter growing seasons. However, most crop plants will grow best in an optimum temperature range. Climate is one factor that limits which crops can be grown. In Missouri, for example, the below-freezing temperatures prevent citrus fruit from being grown.

Resource availability should also be considered in production decisions because of the related production expenses. Successful crop production relies on the availability of various resources and

their efficient use. Crop production is unprofitable when the cost of providing water, fertilizer, or transportation to storage or market is too great.

Product demand affects the level of crop production in the U.S. and internationally. Crop production decisions should consider the product demand by industry and consumers. If the demand for the product is low, production may be unwise unless the producer has plans to use the product on the farm (e.g., feed for livestock, production of ethanol). Crop production should focus on high-demand crops. However, one exception would be canola. Canola is grown for its high quality vegetable oil. Corn and soybeans are the most common crops that produce vegetable oil. However, canola is grown because its vegetable oil is lower in saturated fats. Demand for canola has been limited. However, as consumers become more aware of healthful eating, demand is expected to increase.

International trade affects the kind and amount of crops grown. The U.S. is no different than any other nation. When a specific resource is needed by the U.S., trade is negotiated for that resource. For example, the U.S. produces far less minerals than it uses. Many minerals are imported from developing countries. Often these countries do not have the capability to produce enough food. Therefore, they trade their surplus mineral resources for U.S. food crops (e.g., wheat, soybeans, and corn).

International Relationships

Crop production is more complex than simply providing food or fiber to consumers. U.S. crop production has an impact on relationships with other countries. One positive impact is that the production and exportation of crops help to stimulate the U.S. economy. Jobs in export industries are provided by producing, processing, and marketing crops. Another advantage of U.S. crop production is the contribution to the country's trade balance. Agriculture exports more agricultural products than it imports. Crop production can also impact international relationships by building allies and friendships with other countries.

Some developing countries produce agricultural crops and sell them on the world market. For some developing countries, the sale of agricultural products may be their primary source of income. Overproduction of crops may drive the crop price down. Lower prices may significantly reduce the income derived from exported crops. Overproduction may also push developing countries out of the market completely. Reduced export trade may be devastating to the economy of a developing country.

Because of limitations in soil quality or water resources, many countries are not able to produce enough food. Export trade may result in a dependency on food imports to feed the population of a developing country. Planning and management are needed to enable developing countries to improve their own agricultural production. Otherwise, developing countries will remain dependent on others for survival.

Effects of Foreign Crop Production on the U.S.

Before the colonies of North America became independent from Europe, agricultural products were traded with Europe and the Caribbean islands. The U.S. is the leading producer and exporter of agricultural products. However, other countries are increasing their food export capabilities. Competition from other countries in the world market is a major concern for agricultural producers in the U.S.

Some countries produce agricultural crops that are not grown in the U.S., such as tea, coffee and certain fiber crops. Other countries produce crops similar to crops grown in the U.S. Consumer demand for these products keeps the market strong. However, when crop production in the U.S. and foreign countries is high, the supply may exceed the demand. Excessive production leads to large surpluses, which results in lower prices for commodities on the world market. Many foreign countries enjoy lower labor costs in producing and processing agricultural crops. Lower labor costs reduce the cost of production, which allows the products to be sold for a lower price. U.S. products must be priced accordingly to be competitive on the world market.

Crop Production and Society Development

Countries that are able to produce crops efficiently tend to be more developed. Countries that are able to supply the food, shelter, and clothing needs of their people may be in a position to devote resources to pursue other endeavors. Because of the efficient crop production of American farmers, U.S. consumers spend less money on food. Therefore, most families have money available for other uses (e.g., education, housing, and leisure). Additional purchases of goods and services stimulate the need for jobs, which generates more employment. This circular process stimulates the economy of a community, state, or nation.

When crop production is efficient, many countries trade beyond their borders to attain resources. National and international trade creates more jobs and secures additional resources for economic expansion. Through international trade, developing countries can acquire and develop capital to aid in their advancement.

Summary

Because of the diversity of Missouri's land and resources, efficient production of crops is possible. Missouri ranks among the top 10 states in crop production in the U.S. Missouri also contributes to international trade by producing crops that are sold on the world market.

Credits

Missouri Agricultural Statistics Service. Missouri Farm Facts. Missouri Department of Agriculture, 1990.

Thomas, G.W.; S.E. Curl; W.F. Bennett. Food and Fiber for a Changing World. IL: Interstate Publishers and Printers, 1976.

McMillen, W. Feeding Multitudes: A History of How Farmers Made America Rich. IL: Interstate Publishers and Printers, 1981.

Doll, R.J.; G.H. Miller; R.D. Rees. International Trade and American Agriculture. Federal Reserve Bank of Kansas City Research Department, 1970.

Lesson 2:
Crop Uses (Products and By-Products)

Agricultural crops are commonly used as food for human or animal consumption. Technology and research have also extended crop usage beyond food. This lesson will address the uses of crops as sources of food and industrial products.

Major Uses of Crops

There are over 300,000 species of plants that have been identified. The majority of these plants are not used as food sources. The term "crop" encompasses any plant grown for a specific reason.

Many crops grown in the U.S. or throughout the world are produced for human or animal consumption. Some crops can be grown to feed both humans and animals. Often these crops are fed to livestock such as beef cattle, chickens, sheep and hogs, which may then be processed for human consumption. Other uses of crops involve the production of various oils for cooking and industrial uses. Another major use of crops is in the production of pharmaceuticals (i.e., medicines).

Other major uses of plants are the production of fibers, sugars, alternative fuels, shelter products, ornamental plants, and stimulants.

Major Crops

Crops can be categorized according to their use. The major categories are: human and animal consumption, oils, pharmaceuticals, fibers, sugars, alternative fuels, shelter, ornamentals, and stimulants.

Crops grown for human and animal consumption - These crops include cereal and grain crops, legumes for seed, fruits, vegetables, nuts, and forages. Cereal grain crops are grasses that are grown for their edible seeds. The U.S. produces seven major grain crops, which are used in the U.S. and/or exported to many other countries. Major grain crops are corn, wheat, barley, oats, rye, rice, sorghum, and soybeans. Less than 10 percent of the corn grown in the U.S. is for human consumption.

Legume plants such as dry beans and peas are important foods in the diet of many Americans and people around the world. They are highly nutritious and relatively inexpensive. Food products made from field beans, field peas, peanuts, cowpeas, and soybeans are found in most grocery stores. Fruits such as apples, peaches, berries, and cherries are grown for human consumption. Vegetables like tomatoes, cucumbers, squash, and potatoes are also grown for human consumption. Pecans, walnuts, etc., are nuts commonly grown for human consumption.

Forage crops are used for animal feeds. Examples of forage crops include tall fescue, clovers, and orchard grass.

Production of various oils - These crops are grown primarily for the oil extracted from the seeds. They are used to produce oils for human consumption and industrial products. People throughout the U.S. are becoming more health conscious and are changing their diets. The use of vegetable oils has grown and is replacing the use of animal fats in cooking. Crops such as soybeans, peanuts, castor beans, corn, and canola produce quality oils for human consumption. Crops such as soybeans, flax, and cotton also produce oils that can be used in industrial products such as paints and stains.

Production of pharmaceuticals - Plants have been used for years to produce medicines. For example, Foxglove is a source for digitalis, which is used today almost exclusively as a heart stimulant and pulse regulator. Plants are grown to produce medicines that can help in controlling malaria and hypertension.

Production of fibers - Cotton, flax, and hemp are examples of fiber crops. They are used to produce materials like textiles or rope. The fibrous plant material in flax is used to produce linen. Flax fiber is also used in the production of paper pulp, binder twine, insulating wallboards, and numerous upholstery products. Besides the fiber portion of the flax plant, the seeds are used to produce linseed oil. Hemp has been used for making rope, twine, sails, tarpaulins, and

numerous other products. Cotton is used in manufacturing cloth and thread in addition to the oil that is extracted from the seed.

Production of sugars - Sugar crops are sugar cane and sugar beets. Sugar cane is a member of the grass family. It is valued for the juices contained in the stem. At maturity, the plant's stems contain sucrose or crystallized sugar. Sugar beets supply over 40 percent of the world's sugar. Sugar beet tops are also processed and used for livestock feed. The sugar beet (fleshy taproot) is processed for its high sucrose content.

Production of alternative fuels - Crops that contain starch or sugars can be processed to produce an alcohol product known as ethyl alcohol or ethanol. Alternative fuel from fibrous or woody plants is known as methyl alcohol or methanol. Grains, tubers and whole plants that contain fibrous materials can be used to produce this fuel. Once these alcohols are produced, they must be distilled before being blended with gasoline to make gasohol. Common crops used to produce alcohol are grain sorghum, wheat, potatoes, sugar beets, sweet sorghum, sugar cane, and corn. Alcohol can also be produced from legume and grass crops.

Production of materials for shelter - Plants used for shelter are predominately trees. Trees grown for lumber products such as dimensional lumber (e.g., 2 x 4s and 2 x 12s), plywoods, and trims can be grown on tree farms. Pines, furs, and hardwoods such as oaks, walnut, cherry, and hickories are used for buildings and furniture.

Production of ornamental plants - Ornamental plants include all plants grown for their beauty. Ornamental plants may be used indoors or outdoors depending on the type of plant. Boston ferns, African violets, impatiens, azaleas, goldenrain trees, flowering crabapple trees, petunias, and lilac are a few examples of ornamental plants.

Production of stimulant crops - Stimulant crops include tea, tobacco, and coffee. Tobacco is primarily grown in the south-eastern U.S. Coffees and teas are grown in South America, India, China, Africa, Japan, and Indonesia.

Products from Corn

Corn is the most widely grown crop in the U.S. Corn can be eaten as corn on the cob (sweet corn), popcorn, cornmeal, or flour. Field corn can be processed to be fed to livestock. Corn can be used to produce vegetable oils, breakfast cereals, refined corn sugar, and starch. Corn can also be processed to make adhesives, dyes, plastics, and alcohol, which is used to make gasohol.

Products from Soybeans

The soybean is another very important agricultural crop. Soybeans can be used as a grain crop or an oilseed crop. Soybeans can be processed into cooking oils, soy flours, shortening, margarines, and soy sauces. Soybean meal is a by-product after the soy-oil has been extracted from the seed. It is used as a protein source in livestock feed.

Soybean oil can be used to make industrial products: printer inks, paints, varnishes, caulking compounds, and linoleum floor coverings. Soybeans and soybean by-products have become very important to the U.S. and many parts of the world. In many parts of the world, soybeans and soybean by-products are used as a protein source in human diets. Tofu (soybean curd) is a soybean product that is gaining in popularity as a food. Many additional products have been developed from soybeans. Many new uses will be discovered in the future.

Determining Plant Use

Humans have been growing plants to eat and to feed livestock for centuries. Human survival is dependent on plants. Although there are over 300,000 types of plants, farmers have cultivated certain plants to mass produce because of the characteristics that these plants possess. Early agricultural producers selected plants by trial and error. The selection criteria related to the plant's usefulness as a human or animal food.

Through the use of modern technology and research, scientists are able to determine the nutritional requirements of humans and animals. They can also identify plants that can best supply these nutritional needs. The nutritive value

(protein content, carbohydrate content, oil content, etc.) of plant leaves, stems, roots, or seeds and the plant's palatability (pleasing taste) are important factors in determining plant use.

Plants are used for more than human food or animal feed. The use of plant parts (stems, leaves, roots, and seeds) for specific products other than food is another characteristic that determines plant use. New uses for crop plants have been discovered to meet the needs of a changing world. For example, researchers have found that the seed of the jojoba plant contains about 50 percent oil which, after processing, yields a liquid wax. Jojoba wax can serve as a substitute for furniture polishes or extenders for other waxes.

Many plants have been produced for many years. One such plant is the rubber tree, which provides latex that is processed into rubber for tires and other industrial materials. New crops such as canola are growing in popularity. Canola produces a high quality vegetable oil that provides an alternative source of food and industrial products. Agricultural scientists continue to conduct research on plants to identify new and alternative products.

Summary

Plant crops have many uses. Human food, animal feed, oils, pharmaceuticals, sugars, beverages, and fibers are produced through the cultivation of plants with specific characteristics. Because of growing world needs, scientists continue to develop new plant products through the use of research and technology.

Credits

Cooper, E.L. Agriscience: Fundamentals and Applications. Albany, NY: Delmar, 1990.

Delorit, R.J.; J.L. Greub; H.L. Ahlgren. Crop Production. 5th ed. NJ: Prentice Hall, 1984.

Chapman, S.R; L.P. Carter. Crop Production: Principles and Practices. San Francisco, CA: W.H. Freeman and Co., 1976.

Lesson 3:
Plant and Seed Identification

Weeds rob crops of sunlight, nutrients, and water, which are needed for proper growth and development of crops. In order to effectively control crop pests such as weeds, proper and early detection is necessary. Unfortunately, weeds are not easy to identify. The ability to identify weed and crop plants and seeds is necessary to effectively manage crop production.

Seed Identification

Seed identification is important for seed selection and weed control. Some seeds vary greatly, while others are very much alike. The five characteristics used in seed identification are size, shape, color, surface markings, and other botanical characteristics. Table 3.1, "Descriptions of Selected Crop Seeds" and Table 3.2, "Descriptions of Selected Weed Seeds," identify the characteristics of common crop and weed seeds.

Weed Classes

Loss of and damage to crops caused by weeds cost American farmers millions of dollars each year. These losses increase production costs and reduce profit. Weeds also serve as hosts to insects and diseases. The presence of weeds in a field can weaken crop plants, making them more susceptible to diseases.

Weeds can also be harmful to animals and people. Certain weeds can cause severe illness and even death when eaten. Steps have been taken to properly identify and classify weeds that pose health problems. The three classifications of weeds are prohibited, noxious, and common.

Prohibited weeds such as Canadian thistle, field bindweed, and Johnson grass are difficult to control because of their growth, length of life, or abundant seed production. Missouri law prohibits the sale of agricultural crop seed that contains prohibited weed seeds.

Giant foxtail, dodder, and quackgrass are examples of noxious weeds that can be controlled, but with difficulty. The presence of noxious weed seeds in agricultural crop seed is restricted in Missouri.

Common weeds like crabgrass, cocklebur, and chickweed are those weeds that are not classified as prohibited or noxious. These weeds are relatively easy to control but interfere with agricultural production by reducing crop yields and increasing production costs.

Plant Identification

Botanical and agronomic characteristics are used to identify crop and weed plants. There are five main characteristics that can be used to identify crop and weed plants. These characteristics include: 1) leaf shape, 2) stem, 3) flower, 4) root, and 5) other characteristics. Table 3.3, "Descriptions of Selected Crop Plants," and Table 3.4, "Descriptions of Selected Weed Plants," present characteristics of crop and weed plants. Additional information on plant life cycle, plant height, and where the plant is most commonly found may also be helpful in plant identification.

Summary

Identification of crop and weed seeds and plants is important for crop production. Proper identification and control of weeds increase profitability. Some weeds are harmful to animal and human health. Weeds are classified as prohibited, noxious, and common.

Credits

Broadleaf and Grass and Grasslike Weed Vegetative Identification Keys. Cooperative Extension Service, University of Illinois, n.d.

Crop Plants: Color Photos and Descriptions. University of Illinois: Vocational Agriculture Service, 1981.

Delorit, R.J.; L.J. Greub; H.L. Alhgren. Crop Production. 5th ed. NJ: Prentice-Hall, Inc., 1984.

Dierker, William W. Grasses and Grasslike Plants of Cultivated Fields and Pastures in Missouri. University of Missouri-Columbia: University Extension, n.d.

Identification of Grasses and Legumes. University of Missouri-Columbia: Instructional Materials Laboratory, 1980.

University of Missouri-Columbia: University Extension agricultural publications

1. RP0089: Annual Broadleaf Weed Seedling Identification
2. G04850: Common Names of Weeds in Missouri Field Crops
3. G04863: Pasture Weeds (Perennials)
4. RP0281: Weeds of the North Central States

Glossary of Terms Used in Identification

Auricle: Claw-like appendages at the junction of the leaf blade and leaf sheath of grasses.

Awn: A hair-like projection occurring on the lemma of a seed.

Callus: Enlarged base at end of lemma.

Culm: Stem

Hilum: The scar at the point of attachment of a seed to the pod.

Lemma: The husk on the back, dorsal side of the grass seed.

Ligule: Membranous, upright structure located on the collar between leaf blade and leaf sheath of grasses.

Palea: The husk on the front, ventricle side of the grass seed.

Palmately trifoliolate: No distinct petiolule bearing central-terminal leaflet.

Pinnately trifoliolate: Central-terminal leaflet borne on a conspicuous petiolule.

Pubescence: Hairiness of leaves.

Rachilla: A small stem to which a grass seed is attached to the branch or stem.

Rhizome: Underground creeping stem.

Stipule: Leaf-like structure from either side of the leaf base.

Stolon: Above ground, horizontal stem.

Table [illegible] - Descriptions of Selected Crop Seeds (Grain, Forage, Legume, [illegible] and Other)

Seed	Botanical Classification	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Corn	Monocotyledon	cereal grain, feed, food, oil crop	summer annual	varied	semi-round to elongated flat sided	yellow	pronounced wrinkle or dent on top	
Wheat	Monocotyledon	cereal grain, food, feed	winter annual or summer annual	3-10 mm long 3-5 mm wide	oblong to rounded, or fish-backed	brownish to amber	deep crease with rounded cheeks	brush at pistillate extremity
Oats	Monocotyledon	cereal grain	annual, winter annual	8-10 mm long 1.6-3.2 mm wide	spindle shaped	varies from white to yellow gray and red to black	furrowed on one side	covered with moderately long, fine, silky hairs
Rye	Monocotyledon	cereal grain, hay, cover crop	annual, winter annual	6.0-9.0 mm long	slightly higher than thick	glaze brown, brownish olive, greenish brown, bluish green or yellow	longitudinally channeled	lemma is broad, keeled, terminally awned
Barley	Monocotyledon	cereal grain, food, feed	summer or winter annual	10.0-12.0 mm long	narrowly ovoid	creamy white, black, red, purple, or blue	irregularly wrinkled	rachilla is a small, long; or short-haired structure lying within the crease
Rice	Monocotyledon	cereal grain	summer annual	3.5-8 mm long 1.3-2.3 mm thick	shaped like a pelican beak	white	enclosed in light to dark yellow lemma and palea	
Soybean	Dicotyledon	cereal grain and oil	summer annual	varied	round to ovoid	straw to buff tan colored	hilum colors from buff to black	hulls are brown to tan with hairy surface
Sudangrass	Monocotyledon	forage, hay	annual	6.0 mm long		light gray		
Pearl Millet	Monocotyledon	forage, hay, silage	annual	3.0-4.0 mm long 2.25 mm wide	obovoid	yellowish gray	smooth	embryo has a reddish tinge
Kentucky Bluegrass	Monocotyledon	forage	perennial	2 mm long	long, narrow	light gray	lemma, showing numerous veins and nerves	lemma somewhat curved around palea
Rape	Dicotyledon	forage	biennial	1 1/2-2 mm across	spheroid to irregularly globase	dark reddish brown to purplish black	small hilum evident	
Red Top	Monocotyledon	hay, forage	perennial	1.0 mm long	ovoid	translucent reddish	rough coat	lemma and palea appear much longer than caryopsis

Table 3.1 - Descriptions of Selected Crop Seeds (Grain, Forage, Legume, Fiber and Other) continued

Seed	Botanical Classification	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Orchard grass	Monocotyledon	forage	perennial	5.0 mm long	boat shaped	straw colored	finely hairy dorsal nerves	hulls dull with short, curved awn
Reed Canary Grass	Monocotyledon	forage	perennial	3.0 mm long	carrot shaped	olive brown	very shiny	paleas sparsley covered with long hairs
Tall Fescue	Monocotyledon	forage	perennial	5 mm long	rounded knobbed rachilla w/blunt tip	light gray		light purple tinge on the glumes or chaff
Timothy	Monocotyledon	forage	perennial	1 mm long	small plump ovoid	light straw	rough surface	caryopsis light brown
Brome-grass	Monocotyledon	forage	perennial	11 mm long	long and thin	brownish	chaffy appearance, strongly veined	light papery appearance
Bermuda grass	Monocotyledon	forage	perennial		boat shaped	straw yellow		sharp pointed at apex
Perennial Ryegrass	Monocotyledon	forage	perennial	6 mm long	round, knobbed rachilla with blunt tip	light gray	chaffy appearance	awnless rachilla lies flat against seed with broken appearance
Annual Ryegrass	Monocotyledon	forage	perennial	6 mm long	round, knobbed rachilla with blunt tip	light gray	chaffy appearance	awn is present
Red Clover	Dicotyledon	legume, forage	perennial	2.0 mm long	heart shaped and rounded	green-yellow, tan to purple	smooth surface and shiny with notched side	hilum located at the end of the seed
White Clover	Dicotyledon	legume, forage	perennial	1.2 mm long	very small, heart shaped	light yellow to tan to brown	smooth surface with notched side	hilum located at end of the seed
Crimson Clover	Dicotyledon	legume, forage	winter annual	2.4 mm long	flat, oval	yellow to yellowish-orange	smooth surface	pinkish red on hilum side
Alsike Clover	Dicotyledon	legume, forage	perennial	1.5 mm long	round, heart shaped	greenish black to mixed with yellow	smooth surface	hilum on side
Sweet Clover	Dicotyledon	legume, forage	biennial or annual	2.0 mm long	catcher's mitt, flattened ellipsoidal	yellow sweet = speckled goldened yellow, white sweet = golden yellow	slightly notched or lobed with longitudinal furrow	vanilla-like aroma

Table 11 - Descriptions of Selected Crop Seeds (Grain, Forage, Legume, Fiber and Other) continued

Seed	Botanical Classification	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Korean Lespedeza	Dicotyledon	legume, forage	summer annual	2.0 mm long	elm leaf shape	hulless or naked seed is black	prominent veins w/smooth surface	hilum is reddish-brown
Sericea Lespedeza	Dicotyledon	legume, forage	perennial	2 to 2.5 mm long, 1.5 mm wide	ovate	light green to light tan, green flecked w/purple or brownish-purple	smooth surface	hilum on side of barely, notched end
Common Lespedeza	Dicotyledon	legume, forage	annual	2.2 mm long	ovate	naked seed is black to purple-mottled	smooth surface	long prominent sepals
Alfalfa	Dicotyledon	legume, forage	perennial	2.4 mm long	kidney bean shaped	yellow to olive-green	longitudinal furrow not parallel to margin	seed coat not shiny, flat on one side
Birdsfoot Trefoil	Dicotyledon	legume, forage	perennial	1.0 mm long	small, plump, fairly thick, irregularly heart-shaped	dark brown to gun metal	semi-smooth surface	shiny seed coat, hilum on edge or side
Hairy Vetch	Dicotyledon	legume forage	annual, winter annual	size of buckshot	round	dark gray to black	rough seed coat	oval shaped hilum
Castorbean	Dicotyledon	oil	perennial	10.0 mm long	large tick-shaped	mottled w/gray and brown markings or black variations w/white	semi-rough surface	hilum or caruncle prominate at end of seed
Cotton	Dicotyledon	fiber, oil, feed, food	perennial (annual)		ovate	dark brown covered with grayish fuzz	tough, leathery hull	pointed at attachment end
Tobacco	Dicotyledon	drug crop	summer annual	very tiny (sand grain size)	round	dull brown	rough seed coat	when magnified seed shows definite rippling
Flax	Dicotyledon	fiber	summer annual, winter annual in warm climate	3.6 to 5 mm long	pear-shaped, flat	light brown to yellow-mottled greenish yellow to nearly black	smooth and shiny surface	hilum mainly on small end of seed
Sunflower	Dicotyledon	feed, silage, oil	summer annual	6.0 to 10 mm long	elongated rhomboid achene	black to gray with white streaks	semi-smooth surface and veined	hairy at tip

Table 3.2 - Descriptions of Selected Weed Seeds (Prohibited, Noxious, Common)

Seed	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Canadian Thistle	prohibited	perennial	4.5 mm long	slightly tapered	brown	smooth coated	ridge around blossom end
Field bindweed	prohibited	perennial	3 mm long	long with 1 rounded and 2 flattened sides	dark brownish-gray	rough coated	very irregular seed
Johnson grass	prohibited	perennial	3 mm long	oval	reddish-brown	marked with fine lines on surface	awn that is easily broken off
Sorghum almum	prohibited	perennial	2.7 long	oval	reddish-brown		
Buckhorn plantain	noxious	perennial	small	boat shaped	brown	shiny and smooth	indentation in the middle of one side, stick when damp
Curled dock	noxious	perennial	2.0 - 2.5 mm long	triangular, sharp-edged	brown	smooth seed coat	3 heart-shaped bracts with smooth edges
Dodders	noxious	annual	size of white clover	round to pear shaped	brown	roughened seed coat	triangular in cross-section
Giant foxtail	noxious	annual	1.5 mm long	intermediate between green and yellow foxtail	mostly greenish, straw or dark brown	glossy margins of palea	
Hedge bindweed	noxious	perennial		obovoid-wedge shape	slate colored to black	dull surface color	1 rounded and 2 flattended sides
Leafy spurge	noxious	perennial		thick oval	light gray or with brownish spots	smooth surface	often yellowish out growth near point of attachment
Ox-eye daisy	noxious	perennial	1.5 mm long	oval, usually curved with one side straight and other side convex	black with 8 to 10 white to gray ridges	rough surface (ribbed)	long prominent knob like scar on top
Perennial peppergrass	noxious	annual or winter annual	1.5 - 1.8 mm long	slightly oblong	reddish brown	semi-smooth surface	point of attachment at end
Quackgrass	noxious	perennial	8.0 mm long	oblong and narrow	yellow-brown		lateral bulge is present on back of lemma
Red or Sheep Sorrel	noxious	perennial	1.0 mm long	3-sided	reddish-brown	dull, rough surface	
Russian Thistle	noxious	annual		conical shaped	gray to yellowish-brown	spirally ridged	

Table 3.2 - Descriptions of Selected Weed Seeds (Prohibited, Noxious, Common) continued

Seed	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Wild Carrot	noxious	biennial	2.5 mm long	oblong and flat on one side	grayish-brown	4-heavy, long-bristled ridges	
Wild Garlic and Onion	noxious	perennial	often the size of wheat kernels	garlic = flat on one side and obovoid	black to dark brown		
Yellow Star-Thistle	noxious		1/16 - 1/8 inch long	1 type has pappus bristles - the other doesn't	1 type is pale yellow the other is dark grayish		
Hemp	noxious	annual	3 mm long	oval	mottled brown to green	semi-smooth surface	
Barnyard grass	common	annual	3.0 - 4.0 mm long	oval	tan to brown	longitudinal ridges	awned and awnless
Cheat	common	winter annual, annual	10.0 - 15.0 mm long	oblong and flat with one end wider	tan to brown		large lemma with a long awn
Chickweed	common	winter annual, annual	very small seed	somewhat heart shaped but nearly rounded	dull reddish-brown	roughened by curved rows of minute tubercules	
Cocklebur	common	annual	1.3 mm long	slender with pointed tips	dark brown	ridged surface	
Corn Cockle	common	winter annual	3 mm long	triangular	black	covered with rows of sharp tubercles	
Crabgrass	common	annual	2.4 mm long	small canoe shaped	green to greenish purple	semi-smooth surface	pointed lemma
Dandelion	common	perennial	4.5 mm long	elongated with slender tip	tannish	rough coated and ridged	tip bears a tuft of hairs
Fall panicum	common	annual	1.5 mm long	oblong but semi-flat	yellow	smooth surface	readily separated from hull when ripe
Foxtail-(green)	common	annual	1.5 - 2 mm long	ovate to narrowly ovate	dark blotched upon a light straw background	longitudinally striate or weakly cross-wrinkled	
Foxtail-(yellow)	common	annual	1.5 - 2 mm long	broadly oval	mostly yellowish but some dark brown	lemma, coarsely wrinkled	
Horse-nettle	common	perennial	1.5 mm long	obovate	glossy yellow to orange	faintly roughened by low curving ridges	
Jimson Weed	common	annual		kidney shaped flattened	dark brown to black	irregular and pitted	

Table 3.2 - Descriptions of Selected Weed Seeds (Prohibited, Noxious, Common) continued

Seed	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Lamb's Quarters	common	annual	1.5 mm long	disk-shaped	black	small niche in the edge	may be enclosed by a grayish hull
Milkweed (climbing)	common	perennial		flattened, oval	brown	rough coat	tuft of silky, white hairs at tip
Milkweed (common)	common	perennial		flat, oval	brown	rough coat	tuft of silky, white hairs at tip
Morning-glory	common	annuals and perennials	various sizes	round with 2 flattened sides or round, flattened and fringed with hairs	dark gray or black		
Musk Thistle	common	biennial	4.5 mm long	long, curved	glossy yellowish-brown	rough and ridged	
Mustard (wild)	common	annual, winter annual	1.5 mm long	round	black, bluish or brown	smooth and hard surface	
Nutgrass (Yellow Nutsedge)	common	perennial	1.6 mm long	3 angled-small with blunt ends	yellowish-brown		
Plantain (bracted)	common	annual, winter annual	3 mm long	boat shaped with groove across oval side of seed	dull light brown	2 white scars in indentation on inner surface	
Pigweed (smooth)	common	annual	1.0 - 1.2 mm long	ovate, lens shaped and notched at narrow end	shiny black		
Ragweed (giant)	common	annual	.6 to 1.3 cm long	shaped like long kings crown with five to 10 spikes at top	gray to brown	rough surface	
Shepard's Purse	common	annual, winter annual	1.0 mm long	small and oblong	yellowish	distinct longitudinal furrows on each side	
Smartweed, Pennsylvania	common	annual	3.0 mm long	circular flat at least one surface concave	reddish-brown to black		usually stays in husk
Spiny Sida (prickly sida)	common	annual	1.6 mm long	3 angled egg-shaped	dull dark reddish-brown	rough odd shaped	
Velvet leaf	common	annual	3 mm long	flattened notched	grayish-brown	roudh surface	
Wild Buckwheat	common	annual	3 mm long	3-sided	black to brown		often covered with a rough dull brown hull

Table 3.3 - Descriptions of Selected Crop Plants (Grain, Forage, Legume, Fiber)

Plant	Botanical Classification	Agronomic Classification	Life Cycle	Plant Height	Leaves	Stem (culm)	Flower (inflorescence)	Root
Corn	monocotyledon	feed, food, oil crop	summer annual	varies depending on variety grown	thin, flat, expanded blade with a midrib and smaller veins with pronounced liqules	alternating nodes and internodes average 100 inches in length and 1 1/4 inches in diameter	functional staminate flowers in the tassle, functional pistallate flower in the silks	seminal and adventitious
Wheat	monocotyledon	cereal grain, food, feed	winter annual or summer annual	range from 1-4 feet in height depending on cultivar	composed of sheath, blade, liqule and auricle	culm - hollow jointed cylinder constituting 3-6 nodes and internodes	spike type, typically a single spikelet per node, 3-4 florets per spikelet	seminal and coronal, tillers are common
Oats	monocotyledon	cereal grain	annual, winter annual	range slightly less than 2 feet to 5 feet depending on cultivar	solitary sessile leaves in two ranks	culm-series of nodes and internodes that alternate solitary sessile leaves	panicle consists of a main axis terminating in a single multiflorous spikelet	fibrous, seedling and permanent
Rye	monocotyledon	cereal grain, hay, cover crop	annual, winter annual	typically more than 5 feet tall some up to 6 feet tall	coarser and more bluish in color than those of wheat	larger and longer than those of wheat	spike type inflorescence like wheat except with 3 florets per spikelet	seminal and coronal with some tillers
Barley	monocotyledon	cereal grain, food, feed	summer or winter annual	range from 1-4 feet depending on cultivar	presence of large auricles and absence of prominent ligule	culm is hollow jointed cylinder	spike type like wheat with 3 spikelets per rachis node with single florets	seminal and coronal, tillers are common
Rice	monocotyledon	cereal grain	summer annual	2-6 feet tall	long, thin, narrow, coarse, and ribbed	erect culms that are hollow and consist of nodes that vary in number	loose, freely branched, panicle-type inflorescence, each floret has six stamens and two, long styles	shallow root system, tillers under poor growing conditions
Soybean	dicotyledon	cereal grains oil, forage	summer annual	2-4 feet tall	trifoliate and pubescent	erect, very bushy and branched	small purple and white borne in axillary racemes	taproot with branches
Sudangrass	monocotyledon	forage, hay	annual	3-5 feet when broadcast, 6-8 feet when grown in rows	soft with numerous open penicles	slender		numerous tillers, rarely any branches and no rootstocks
Pearl Millet	monocotyledon	forage, hay, silage	annual	2-5 m	long, pointed, with finely serrated margins	pithy, erect	thick, cylindrical spikes, 20-50 cm long and 2-4 cm in diameter	free tillering from axillary meristems

Table 3.3 - Descriptions of Selected Crop Plants (Grain, Forage, Legume, Fiber) continued

Plant	Botanical Classification	Agronomic Classification	Life Cycle	Plant Height	Leaves	Stem (culm)	Flower (inflorescence)	Root
Kentucky Bluegrass	monocotyledon	forage	perennial	varied height depending on use	green and V shaped in cross sections	fine and cylindrical	spreading panicles	creeping underground stems, Rhizomes
Rape	dicotyledon	forage	biennial	2-2 1/2 feet tall	mostly glabrous; basel leaves 4-12 inches long	much branching from an erect pithy stem	elongated raceme; light yellow flower 1/4 to 3/4 inch across	branched taproot
Red Top	monocotyledon	hay, forage	perennial	attain 1 m	flat, sharp pointed with ligules that are .6 cm long and pointed	creeping but mostly upright	panicles are reddish and loosely pyramidal in shape	shallow root stocks, vigorous, 2-6 inches long
Orchard grass	monocotyledon	forage	perennial	60 cm to 2 m	flattened and strongly keeled. Ligule membraneous and 3-10 mm long. No auricles	flowering culms that bear few basal leaves	spikelets bear 2-5 florets	fibrous root system but deep tillers are produced
Reed Canary grass	monocotyledon	forage	perennial	60 - 240 cm	flattened with sharp point	tall, stout and leafy	semi-dense spikelet panicles of 5-20 cm	has short, scaly rhizomes
Tall Fescue	monocotyledon	forage	perennial	2 feet	numerous shiny, dark green, ribbed, ciliated auricles and collars	erect, stout, smooth	branched panicle head 10-35 cm long	may or may not have short rhizomes, massive root system fibrous
Timothy	monocotyledon	forage	perennial	80-110 cm	flat, elongated	erect culms	dense, cylindrical spikelet inflorescence one flowered	many tillers, shallow but fibrous
Bromegrass	monocotyledon	forage	perennial	5 feet	long, flat with center rib	many erect, stout culms	numerous spikelets, florescence are made up of 5-10 florets	extensive fibrous system
Bermuda grass	monocotyledon	forage	perennial	mainly a creeping pattern can grow up to 6-12 inches	smooth to slightly hairy, and fairly coarse, ligule is a circle of white hairs	very leafy, short internodes	erect panicles with five spikelets	adventitious roots with rhizomes and stolens
Perennial Ryegrass	monocotyledon	forage	perennial	90 cm	ligules up to 2.5 mm long; may or may not have auricles	erect or spreading	straight or slightly curved spikes up to 30 cm, contain 5-40 spikelets	fibrous

Table 3.3 - Descriptions of Selected Crop Plants (Grain, Forage, Legume, Fiber) continued

Plant	Botanical Classification	Agronomic Classification	Life Cycle	Plant Height	Leaves	Stem (culm)	Flower (inflorescence)	Root
Annual Ryegrass	monocotyledon	forage	perennial	120 cm	leaf sheaths are glabrous, ligules up to 4 mm long auricles usually present	erect or spreading	straight or curved up to 30 cm in length each spike up to 40 spikelets	fibrous
Red Clover	dicotyledon	legume forage	perennial	30-90 cm	usually 3 oblong leaflets, generally hairy	numerous leafy, rising from crown	flowers on heads (compact clusters) heads usually consist of 125 rose colored flowers	taproot system with many secondary branches
White Clover	dicotyledon	legume forage	perennial	30-90 cm	long-petioled, trifoliate usually marked with white V	fleshy stem with short internodes	usually white, occasionally pinkish on an almost globose head	has stolons with a primary root with adventitious roots
Crimson Clover	dicotyledon	legume forage	winter annual	30-90 cm	three leaflets broadly obovate at tip, narrow at base and hairy	fleshy, stout stems with short internodes	bright crimson red color, conical flower head	central taproot with many fibrous roots
Alsike Clover	dicotyledon	legume forage	perennial	under favorable conditions 2.5-5 ft.	3-leaflets on a main axis	smooth, leaf, erect	vary from white to almost rose	tap root and secondary roots
Sweet Clover	dicotyledon	legume forage	biennial or annual	may reach 2.8 m	trifoliate leaves that are toothed around margins	erect stems that vary from 3-6 feet tall	yellow or white flowers	deep tap root
Korean Lespedeza	dicotyledon	legume forage	summer annual	30 inches	larger, coarser with prominent stipules	hairy	born in clusters at tips of branches (petelous)	extensive but relatively shallow
Sericea Lespedeza	dicotyledon	legume forage	perennial	.5-1 m	long and narrow, indented at end	coarse, hard stems, hairy	purple or yellow petalous and apetalous	deep taproot
Common Lespedeza	dicotyledon	legume forage	annual	4-30 inches	narrow leaflets, small stipules	upright with numerous nodes, hairy	small purple	taproot
Alfalfa	dicotyledon	legume forage	perennial	60-90 cm	pinnately trifoliolate, alternately on stem	short, that produce other leafy branches	purple or yellow depending on cultivar	creeping rooted and taproot with branches

Table 3.3 - Descriptions of Selected Crop Plants (Grain, Forage, Legume, Fiber) continued

Plant	Botanical Classification	Agronomic Classification	Life Cycle	Plant Height	Leaves	Stem (culm)	Flower (inflorescence)	Root
Birdsfoot Trefoil	dicotyledon	legume forage	perennial	60-90 cm	compound leaves, alternately attached five leaflets	numerous, fine stems 12-30 inches in height	typical umbrel with 4-8 florets dark yellow to orange	deep taproot that is branched
Hairy Vetch	dicotyledon	legume forage	annual, winter annual	60-180 cm	pinnate leaflets which have ten drils	stout	white or purple in clusters or raceme	taproot
Castorbean	dicotyledon	oil	annual or perennial depending on climate grown	3-12 feet for commercial type		coarse	racemes bearing female on upper and male on lower	taproot system with lateral roots
Cotton	dicotyledon	fiber, oil, feed, food	annual in tropics, or short lived perennial	2-5 feet	large, hairy, simple with 3-5 lobes borne on petioles with stipules, palmately veined	woody, stout stems with alternate branching	alternate sides of fruiting branch complete and perfect, 5 large sepals, 5 petals	deep taproot and widely branching secondary system
Tobacco	dicotyledon	drug crop	summer annual	vary from 4-6 feet	simple, alternate leaves up to 2 ft. long and 1 ft. wide covered with sticky hairs	erect, stout yet fleshy that terminates in a raceme type inflorescence	complete and perfect, calyx of 5 sepals, coralla of 5 petals fused into a floral tube usually pink	generally shallow branched system 2-3 ft. depth
Flax	dicotyledon	fiber	summer annual, in warm climates winter annual	ranges 1-4 feet	short, narrow alternate on stem and are sessile	narrow and branch trim the base	white or blue complete and perfect, five sepals, five petals, five stamens	poorly branched taproot, 2 ft. depth
Sunflower	dicotyledon	feed, silage, oil	summer annual	5-20 feet in height	alternate, ovate	stout, erect, simple, 1-3 inch diameter	6-12 inch diameter, 40-80-golden petals surrounding a brown to nearly black disk	fibrous and branching system

Table 4 - Descriptions of Selected Weed Plants (Prohibited, Noxious, Common)

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Canadian Thistle	prohibited	perennial	2-5 feet	crinkled edges and spiny margins	grooved, slightly hairy	male and female on different plants, usually numerous and compact, 1.9 cm or less diameter	extend several feet down and horizontally	in all crops
Field Bindweed	prohibited	perennial	2-7 feet	ovate with spreading basal lobes	smooth, slender, twining or spreading over ground	white or pink, funnel-shaped 2.5 cm across, single in the axis of the leaves	extensive down 20-30 feet	in and able to spread in all noncultivated areas and under most cropping systems
Johnson grass	prohibited	perennial	1.5-6 feet	alternate, simple, smooth, 6-20" long 1/2-1 1/2" wide	erect, stout	panicles-large, purplish, hairy	freely branching, fibrous, rhizomes, stout, creeping	especially on rich soil, corn, soybeans
Sorghum Almum	prohibited	perennial						
Buckhorn Plantain	noxious	perennial	4-12 inches	ground level in a basal rosette, hairy 2-10" long 1/4-1" wide, 3-5 prominate lengthwise veins	erect, leafless, 4-12" long, terminating with flower spike	numerous, petals in short cylindrical spikes at ends of stem	mostly fibrous	lawns, meadows, pastures, waste places
Curled Dock	noxious	perennial	1-4 feet	alternate mostly basal, smooth, 6-12" long lanceolae with wavy curled edges short petiole	smooth, erect, single or in groups from root crown	dense clusters on branches at tip of stem without petals, small, greenish to reddish brown	large yellow, somewhat taproot	pastures, roadsides, new hay fields
Dodders	noxious	annual	vine like, parasitic, twining around other plants	absent or reduced to small bracts	stringlike, smooth, yellow or orange, branching extensively	numerous, small white, 5 lobes in clusters	small fibrous system	in clovers, alfalfa, and lespedeza
Giant Foxtail	noxious	annual	3-7 feet	covered with short hairs on upper surface	tall, weak	panicle, dense, 3-8", 3-6 bristles per spikelet	fibrous, branching	in cultivated crops
Hedge Bindweed	noxious	perennial	vine like plnt that twines round other plants	large, alternate, usually sharp pointed at tip	smooth, 3-10 ft. long twining or trailing on ground	large, 1 1/2-2" across, white or pinkish	extensive but relatively shallow	in cultivated fields, fence rows and waste areas
Leafy Spurge	noxious	perennial	1-2 feet	alternate on stems narrowly strap shaped, 1/4" wide, usually drooping	erect, smoothly branched at top with milky juice	small, greenish-yellow, petals fused into cuplike structure heart like floral bracts	deep, woody, spreading	in pastures, waste areas, along roadsides in cultivated fields

Table 3.4 - Descriptions of Selected Weed Plants (Prohibited, Noxious, Common) continued

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Ox-eye Daisy	noxious	perennial	1-3 feet	alternate, simple, usually conspicuously lobed, near plant base	smooth, seldom branched	occuring singly at the ends of the stems 1-2 inches diameter; ray flowers-white; disk flowers-yellow	fibrous	in old pastures, especially those low in fertility
Perennial Peppergrass	noxious	annual or winter annual	6-24 inches	alternate, covered with soft hair, arrow shaped	hoary-pubescent or rarely, hairless	white, or greenish, 4 petals, in rather dense racemes at plant top	short, straight, taproot	in winter wheat, first year meadows and waste land
Quackgrass	noxious	perennial	1 1/2-3 ft.	have auricles, liqule 1/32" long, hairy lower sheaths, upper smooth	smooth culms and 3-6 joints	3-7 short-awned florets in a spikelet	extensive rhizomes	in pastures, and open waste lands, most cropped area
Red or Sheep Sorrell	noxious	perennial	6-18"	arrow-shaped 1-3 inches long, thick, smooth, acid to taste	slender, upright, branched at top	yellow to red on raceme near plant top, male and female on different plants	extensive but rather shallow	in pastures, meadows, sometimes lawns
Russian Thistle	noxious	annual	1-3 ft.	cylindrical or awl-shaped, young are soft; later leaves are short, stiff, prickle pointed	young plant-soft and succulant, mature plant-stiff and woody	numerous, small, without petals, axillary on upper branches	taproot	in spring grain and legume seedings
Wild Carrot	noxious	biennial	1-3 ft.	alternate, finely pinnnately divided, hairy-smells like carrots	erect, hairy, stout and branched at top	small, with 5 white petals in umbrels at branch ends	fleshy taproot	in meadows, pastures, roadsides, not in cultivated fields
Wild Garlic	noxious	perennial	1-3 ft.	slender, hollow, nearly round attached to lower stem	tall, smooth, waxy	greenish-white, small on short stems above aerial bublets	fibrous from bulb	in grain fields, pastures
Wild Onion	noxious	perennial	1-2 ft.	flat not hollow at base of plant stem	tall, smooth	clusters of small flowers	fibrous from bulb	in grain fields, pastures
Yellow Star-Thistle	noxious							
Hemp	noxious	annual	2-10 ft.	palmately divided, 5-9 hairy leaflets w/notched edges	coarse, somewhat grooved, rough, and hairy	male and female on separate plants	branched taproot	along ditches, fences, roadsides, wasteland
Barnyard grass	common	annual	1-4 ft.	both sheath and blades, smooth, light green 3/8-5/8" wide	thick, coarse, mostly erect, smooth branches	panicle bearing several compact side branches green or purplish color	fibrous but shallow	in most cropped areas

Table 3.4 - Descriptions of Selected Weed Plants (Prohibited, Noxious, Common) continued

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Cheat	common	winter annual, annual	12-24"	smooth and slightly hairy	erect with few internodes	panicle spikelets on shorter upright stalks	branching and fibrous	grain fields, meadows and waste land
Chickweed	common	winter annual, annual	4-12" tall	small, opposite, simple, broadly ovate, pointed tips, smooth; petioles have hair on one side	branched, creeping	small white 5 deeply notched petals	flibrous and shallow	lawns, gardens, alfalfa
Cocklebur	common	annual	2-4 ft.	alternate, simple, triangular	erect, normally bushy	separate, small male and female together in clusters	taproot, woody, stout	cultivated lands, poor pastures
Corn Cockle	common	winter annual	2-3 ft.	opposite, slender, hairy joined at base	rough, hairy, erect, swollen at joints	large, purple with narrow, green sepals	taproot, shallow	cultivated land
Crabgrass	common	annual	up to 3 ft. long	somewhat hairy 1/4-1/3" wide w/leaf sheaths	stout, smooth, rooting at joints	3-10 segments in whorls at top of stem	spreading, fibrous	lawns, gardens, fields
Dandelion	common	perennial	6-8"	simple, variously lobed, 3-10 inches long, milky juice	never elongates but produces a rosette of leaves	1-2" in diameter of yellow ray flowers	thick, fleshy with branches	lawns, meadows, gardens
Fall Panicum	common	annual	20-50"	smooth, hairy, sheaths heavy short, loose, often purplish	smooth, spreading, often partly, flat on the ground lower nodes swollen	panicle compact spikelets	fibrous roots	in gardens, cultivated fields
Foxtail (green)	common	annual	1-3 ft.	hairless	erect	dense 1-3" long erect near tip	fibrous roots	all places except woods
Foxtail (yellow)	common	annual	1-2 ft.	flat, often w/spiral twist, long hairs on upper	erect	dense, erect, spikelets, 5 or more bristles	fibrous roots	all places except woods
Norse-Nettle	common	perennial	1-4 ft.	alternate, oblong, wavy edged and prickly	simple branched, hairy and prickly	white or bluish, 5-lobed, 1" across in clusters	creeping rootstocks	fields, gardens, snady soils
Jimson Weed	common	annual	2-4 ft.	alternate, large, coarse, smooth, ovate, toothed edges, rank odor	smooth, thick, erect, branching	large funnel-shaped white to pinkish 2-5" long, egg shaped	thick, shallow, branched	in cultivated crops, old feedlots

Table 3.4 - Descriptions of Selected Weed Plants (Prohibited, Noxious, Common) continued

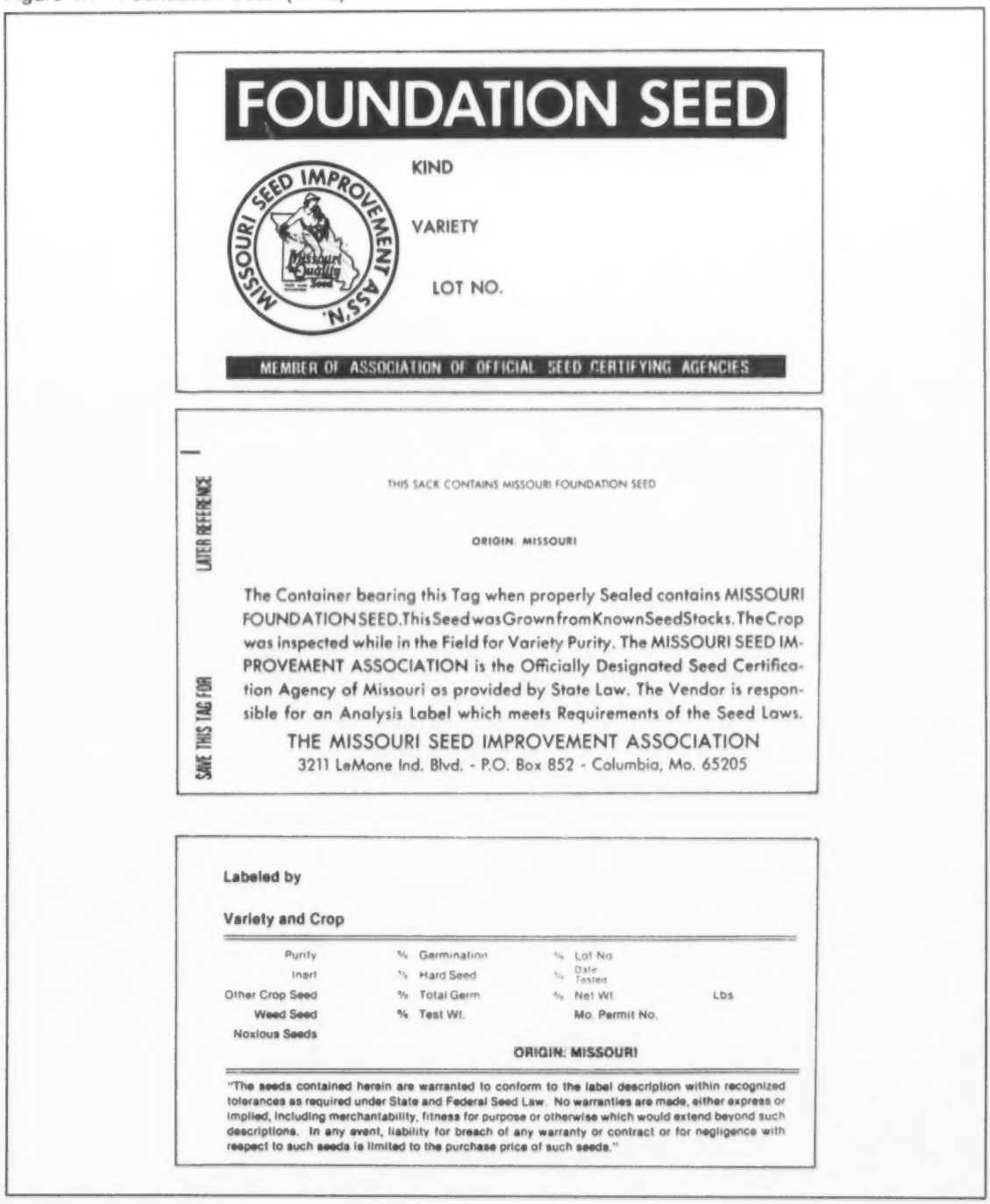
Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Lamb's Quarters	common	annual	3-4 ft.	alternate 1-3" long, smooth, white, mealy-coated	tall, smooth, grooved, often red, green striating	small, green, without petals at branch ends in axils of leaves	short, branched taproot	in cultivated crops
Milkweed (climbing)	common	perennial	climbing, length varies	smooth, heart shaped pointed, long petioles in pairs at nodes	smooth, slender, twining, without milky juice	small, whitish clusters on stalks from the axils of the leaves	spreading root system	fence rows cultivated fields
Milkweed (common)	common	perennial	2-5 ft.	opposite, oblong, rounded, 4-8" long prominent veins	stout, erect, covered w/short hairs, w/milky juice	sweet-smelling pink to white, ball-like clusters at stem tips	thick root stock	pastures, cultivated fields
Morning-glory	common	annuals and perennials	twining plant 2-10 ft. long	alternate, heart shaped, 2-6" long, smooth w/long petioles	trailing, twining, woody	funnel shaped 2-3" diameter, white w/dark purple center	yellowish white, enlarging greatly	cultivated fields, fences, roadsides
Musk Thistle	common	biennial	3-6 ft.	alternate, coarsely toothed	erect spiny wings lower portion branched	heads as much as 2" across, drooping, purple to lavender	large thick root stock	pastures, meadows, roadsides
Mustard (wild)	common	annual, winter annual	2-3 ft.	lower are irregular lobed, toothed w/petioles and bristly hairs	erect, branched, near top bristly hairs	4 yellow petals in clusters at branch ends	branching fibrous	grain fields
Nutgrass (yellow nutsedge)	common	perennial	1-2 ft.	3-ranked, narrow, grasslike, basal	erect, triangular, yellow-green	yellowish-brown, small narrow spikelets on umbrel-like florescence	fibrous	pastures, cultivated fields
Plantain (bracted)	common	annual, winter annual	6-18"	long, loose, hairy, basal	erect, simple, leafless, hairy, terminating in flower spike	numerous, petals in axils of long bracts in spikes	thick root w/small branches	meadows, pastures
Pigweed (smooth)	common	annual	up to 8 ft.	dull green, 6", ovate to lanceolate	branching freely if not crowded	green, small, slender, panicle like spikes	taproot	cultivated fields, yards, fench rows
Ragweed (common)	common	annual	1-4 ft.	nearly smooth, deeply cut into a number of lobes, alternate	rough, hairy, branched	two kinds: male 1-pollen producing, 2-seed producing	shallow rooted	old pastures, roadsides
Shepard's Purse	common	annual, winter annual	1-1 1/2 ft. tall	in rosette at base; coarsely lobed	erect covered with gray hairs	small, white, 4 petaled	branched taproot	non-cultivated areas

Table 3.4 - Descriptions of Selected Weed Plants (Prohibited, Noxious, Common) continued

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Smartweed (PA)	common	annual	1-4 ft.	smooth, pointed, alternate 2-6" long	smooth, swollen at nodes	bright pink or rose, 5 parted in a short spike	thick branched root	cultivated ground
Spiny Sida (prickly sida)	common	annual	1-2 ft.	alternate, simple, oblong, toothed edges	erect, branching, hairy	5-pale yellow petals, solitary or clustered in axils of leaves	taproot slender, branching	cultivated fields, gardens
Velvet leaf	common	annual	6-8 ft.	large, heart shaped, altenate, petioled, hairy, velvety	smooth, covered w/short velvety hairs	3/4" diameter, 5 yellow petals	taproot well developed	in soybeans and corn fields
Wild Buckwheat	common	annual	vine-like varying length	alternate, heart shaped, pointed with smooth edges	smooth, slender, branched at base	small, greenish-white clusters in leaf axis	taproot and branched	non-cultivated areas and cropping areas

Lesson 4:
Certified Seed and Variety Selection

Figure 4.1 - Foundation Seed (white)



FOUNDATION SEED

KIND

VARIETY

LOT NO.

MEMBER OF ASSOCIATION OF OFFICIAL SEED CERTIFYING AGENCIES

SAVE THIS TAG FOR LATER REFERENCE

THIS SACK CONTAINS MISSOURI FOUNDATION SEED

ORIGIN: MISSOURI

The Container bearing this Tag when properly Sealed contains MISSOURI FOUNDATION SEED. This Seed was Grown from Known Seed Stocks. The Crop was inspected while in the Field for Variety Purity. The MISSOURI SEED IMPROVEMENT ASSOCIATION is the Officially Designated Seed Certification Agency of Missouri as provided by State Law. The Vendor is responsible for an Analysis Label which meets Requirements of the Seed Laws.

THE MISSOURI SEED IMPROVEMENT ASSOCIATION
3211 LeMone Ind. Blvd. - P.O. Box 852 - Columbia, Mo. 65205

Labeled by

Variety and Crop

Purity	% Germination	% Lot No.	
Inert	% Hard Seed	% Date Tested	
Other Crop Seed	% Total Germ	% Net Wt.	Lbs
Weed Seed	% Test Wt.	Mo. Permit No.	
Noxious Seeds			

ORIGIN: MISSOURI

"The seeds contained herein are warranted to conform to the label description within recognized tolerances as required under State and Federal Seed Law. No warranties are made, either express or implied, including merchantability, fitness for purpose or otherwise which would extend beyond such descriptions. In any event, liability for breach of any warranty or contract or for negligence with respect to such seeds is limited to the purchase price of such seeds."

Quality crops begin with quality seed. This may sound like a simple statement, but it is not. The process of providing quality seed involves an entire area of agricultural expertise in agricultural research. Agricultural researchers have devoted considerable time and effort to provide dependable, quality seed to farmers. This seed is known as certified seed. This lesson will discuss the characteristics of certified seed, the classes of seed certification, benefits of using certified seed, and factors to consider when selecting a crop variety.

Quality Seed Characteristics

Careful consideration should be given to selecting crop seed. Quality crops possess specific characteristics as do quality seed. Using quality seed improves crop yields an estimated 10 to 20 percent over crops produced from poor seed.

When purchasing seed, farmers should select seed from a good variety. A good variety would be one that has the reputation of producing a quality crop. Good germination is another desirable characteristic. Seeds that fail to germinate are worthless. Other characteristics of quality seed are proper size and development, uniformity in size and shape, absence of seed-borne diseases and insects, absence of prohibited, noxious, and other weed seeds, absence of mixtures with other crop seeds and other varieties, and absence of inert materials.

Seed Certification

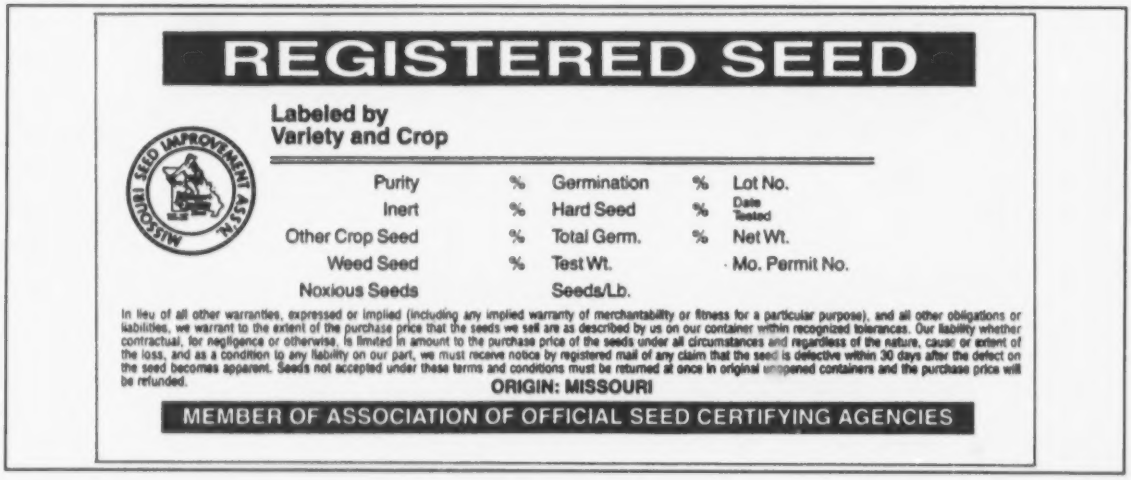
The main objective of seed certification is to monitor the seed production process to ensure that genetic purity is maintained. Agencies that certify seed work with agricultural experiment stations, agronomists, and experienced growers under strict guidelines to produce pure seed varieties.

Certification programs have four classes of seed: breeder seed, foundation seed, registered seed, and certified seed. For seed to be certified, specific criteria must be met. Criteria for certified seed are: 1) the seed must be grown from registered or certified seed stock; 2) the crops produced must pass an inspection for mixtures, weeds, and diseases in the field; and 3) the harvested crop must attain the standard of perfection set by the seed association.

Each seed class must meet specific requirements for certification. Breeder seed is controlled by the originating plant breeder. Breeder seed is used in the production of foundation seed. Although breeder seed does not require identification tags or labels, foundation seed, registered seed, and certified seed do require labels or tags. Only small quantities of breeder seed are produced by commercial seed companies.

Foundation seed is owned and supervised by the original plant breeder, (usually an agricultural

Figure 4.2 - Registered Seed (purple)


REGISTERED SEED

Labeled by
Variety and Crop

Purity	%	Germination	%	Lot No.
Inert	%	Hard Seed	%	Date Tested
Other Crop Seed	%	Total Germ.	%	Net Wt.
Weed Seed	%	Test Wt.		Mo. Permit No.
Noxious Seeds		Seeds/Lb.		

In lieu of all other warranties, expressed or implied (including any implied warranty of merchantability or fitness for a particular purpose), and all other obligations or liabilities, we warrant to the extent of the purchase price that the seeds we sell are as described by us on our container within recognized tolerances. Our liability whether contractual, for negligence or otherwise, is limited in amount to the purchase price of the seeds under all circumstances and regardless of the nature, cause or extent of the loss, and as a condition to any liability on our part, we must receive notice by registered mail of any claim that the seed is defective within 30 days after the defect on the seed becomes apparent. Seeds not accepted under these terms and conditions must be returned at once in original unopened containers and the purchase price will be refunded.

ORIGIN: MISSOURI

MEMBER OF ASSOCIATION OF OFFICIAL SEED CERTIFYING AGENCIES

experiment station). Foundation seed is the parent line for registered and/or certified classes of seed. Foundation seed requires a white identification tag or label. Figure 4.1 shows foundation seed "two tags with analysis."

Registered seed is produced from foundation seed that meets genetic purity and identity guidelines. Registered seed is tagged with a purple identification tag or label. Figure 4.2 shows registered seed "single label." Registered seed may be used to produce certified seed or sold directly to farmers.

Certified seed is produced from foundation or registered seed that meets genetic identity and purity guidelines. Certified seed is tagged with blue identification tags or labels. Figure 4.3 shows certified seed "two label with analysis."

The steps in the production of certified seed are diagrammed in Figure 4.4. The arrows indicate where the seed is used. For example, registered

Figure 4.4 - Steps in the Production of Certified Seed

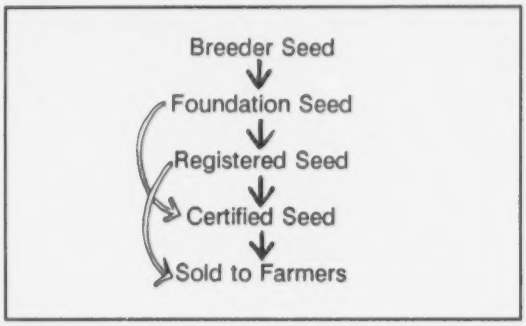
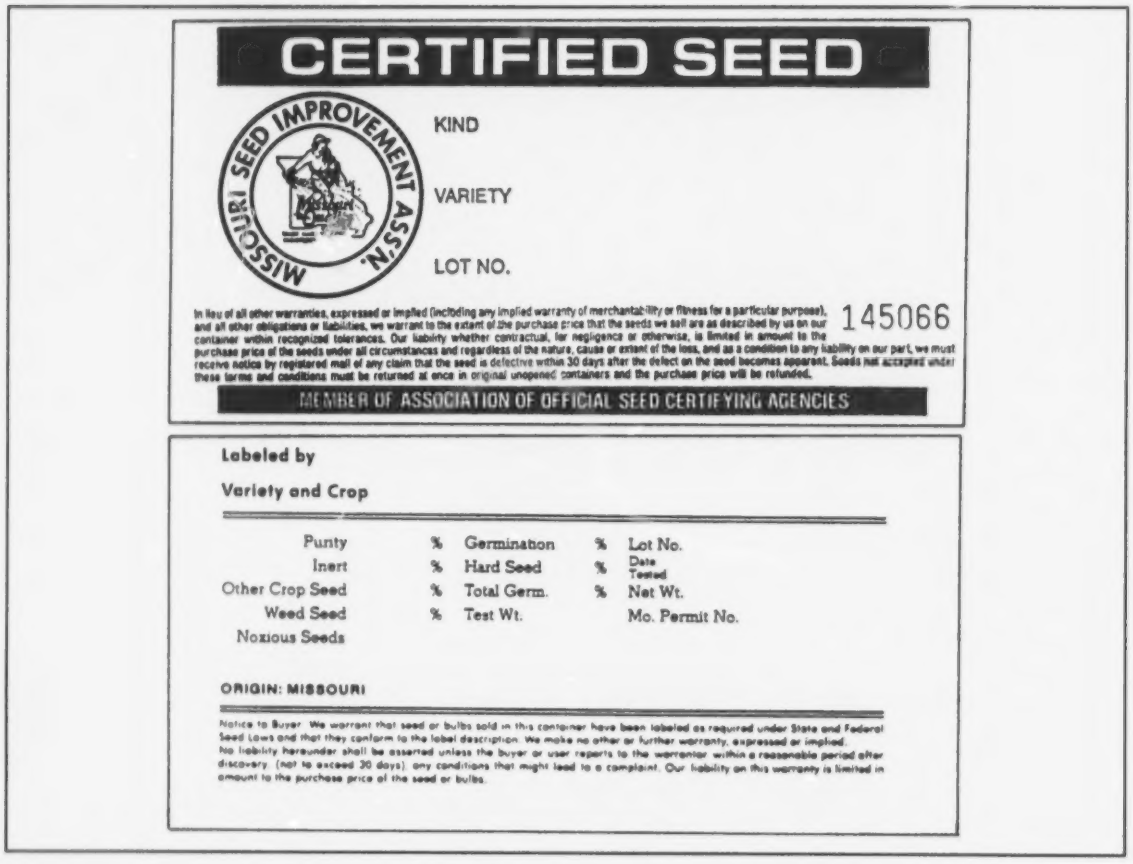


Figure 4.3 - Certified Seed (blue)


CERTIFIED SEED

MISSOURI SEED IMPROVEMENT ASS'N.

KIND

VARIETY

LOT NO.

In lieu of all other warranties, expressed or implied (including any implied warranty of merchantability or fitness for a particular purpose), and all other obligations or liabilities, we warrant to the extant of the purchase price that the seeds we sell are as described by us on our container within recognized tolerances. Our liability whether contractual, for negligence or otherwise, is limited in amount to the purchase price of the seeds under all circumstances and regardless of the nature, cause or extent of the loss, and as a condition to any liability on our part, we must receive notice by registered mail of any claim that the seed is defective within 30 days after the defect on the seed becomes apparent. Seeds not accepted under these terms and conditions must be returned at once in original unopened containers and the purchase price will be refunded.

145066

MEMBER OF ASSOCIATION OF OFFICIAL SEED CERTIFYING AGENCIES

Labeled by

Variety and Crop

Purity	%	Germination	%	Lot No.	
Inert	%	Hard Seed	%	Date Tested	
Other Crop Seed	%	Total Germ.	%	Net Wt.	
Weed Seed	%	Test Wt.		Mo. Permit No.	
Noxious Seeds					

ORIGIN: MISSOURI

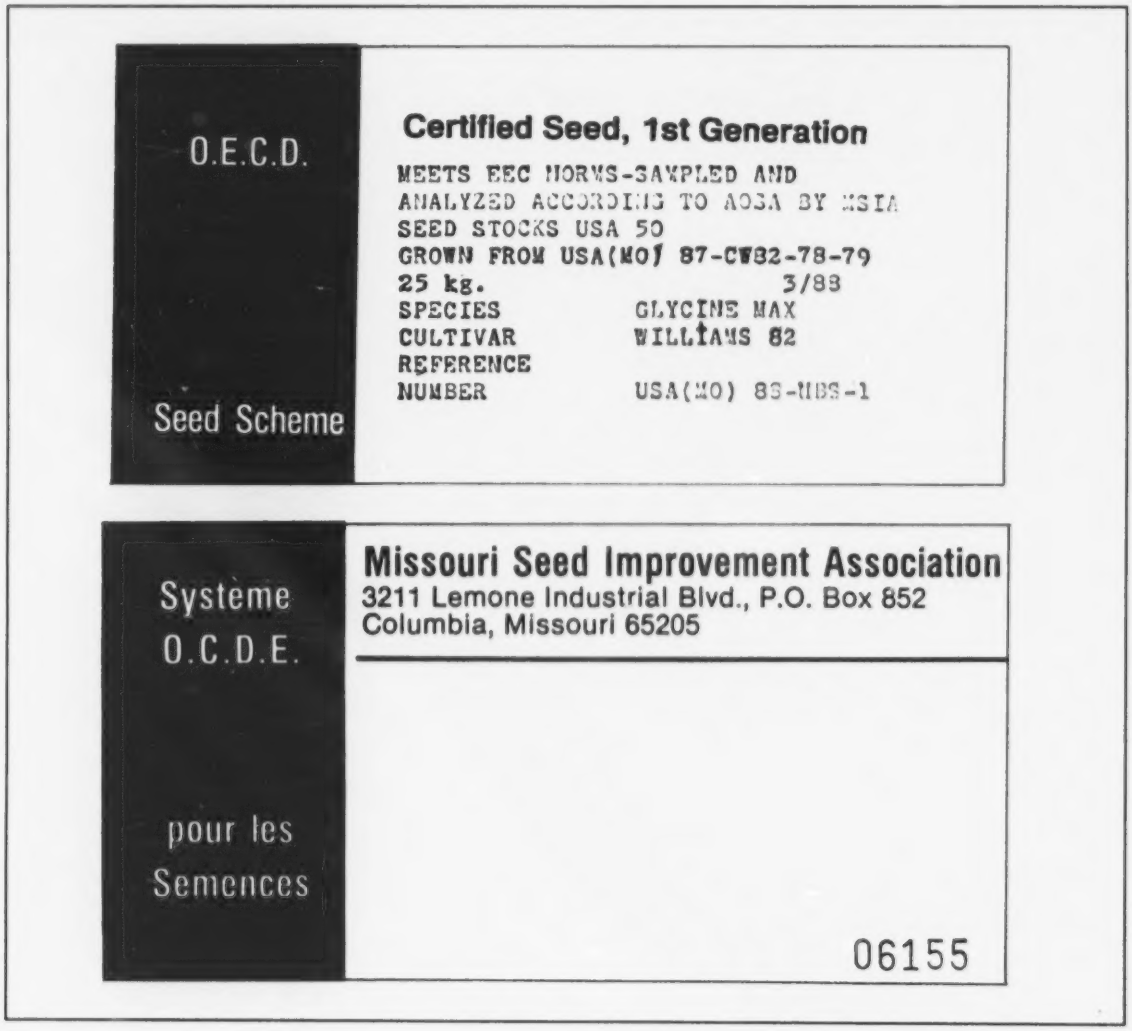
Notice to Buyer: We warrant that seed or bulbs sold in this container have been labeled as required under State and Federal Seed Laws and that they conform to the label description. We make no other or further warranty, expressed or implied. No liability hereunder shall be asserted unless the buyer or user reports to the warrantor within a reasonable period after discovery (not to exceed 30 days) any conditions that might lead to a complaint. Our liability on this warranty is limited in amount to the purchase price of the seed or bulbs.

seed can be sold for the production of certified seed or for the production of field crops by farmers.

Many states produce seed to be exported to other countries. The Organization for Economic Cooperation and Development (O.E.C.D.) has set forth specific minimum requirements that must be met by the seed producers in order to be tagged with an O.E.C.D. tag. The Missouri Seed Improvement Association working with the Missouri Agricultural Experiment Station and the United States Department of Agriculture, Agriculture Research Service provides the needed information to Missouri seed producers for this certification.

Missouri seed producers presently export seed to Argentina, France, Greece, Italy, Mexico, Portugal, Spain, and Turkey. The tags that are placed on approved seed are black and blue in color with the specific information listed on the tag. (Figure 4.5)

Figure 4.5 - O.E.C.D. Tag (black and blue)



Requirements for Seed Certification

Three requirements must be met before seed can be sold to farmers as "certified" seed. First, the seed must be grown from foundation or registered seed stock. Second, the growing and harvested crop must pass an inspection for mixtures, weeds, and diseases. Lastly, the harvested crop of seed must attain the standard of quality set by the seed association. Seed which fails to meet any of the three requirements cannot be sold as "certified" seed in the state.

Benefits of Certified Seed

Farmers have found that the use of certified seed provides specific benefits. Farmers use certified seed because it is guaranteed to be the variety it is advertised to be. Certified seed guarantees no unexpected varieties. The minimum germination rate is guaranteed as listed on the tag. Therefore, the buyer is assured of the viability of the seed that is purchased. Using certified seed guarantees a high quality seed that is free of weed seeds, disease organisms, and insects. However, the cost of certified seed is often more than uncertified seed.

Crop Variety Selection

Many factors should be considered in selecting a crop variety. The environment is one very important factor. Environmental factors such as growing season length, annual precipitation, and the soil type affect the growth and development of crops. Unfortunately, most environmental factors cannot be controlled.

Seed selection should consider cost of varieties and adaptability to local growing conditions.

When selecting seed, it is helpful to know the characteristics of a crop variety. Certified seed provides this information to the buyer. When selecting a crop variety, consideration should be given to the adaptability of the variety. The ability of the variety to adapt to local soil and environmental conditions is vital.

Another important consideration is the yield potential. Matching the variety with the local growing conditions will help to ensure the crop meets its yield potential. Other considerations are purity of the variety, quality of the crop (e.g., protein content and resistance to lodging), disease and insect resistance, and the crop's maturity date.

Summary

Quality seed should be used to produce a quality crop. Using certified seed assures the purchaser of certain quality and purity standards. Selecting varieties according to the cost, adaptability, yield potential, purity, crop quality, and disease and insect resistance is important. Farmers can reduce risk and produce quality crops through the use of certified seed.

Credits

Chapman, S.R.; L.P. Carter. Crop Production: Practices and Principles. San Francisco, CA: W.H. Freeman and Co., 1976.

Missouri Handbook of Seed Certification Standards. The Missouri Seed Improvement Association, n.d.

Lesson 5:
Stand Establishment

Producers are interested in receiving the maximum profit from their crops. In order to receive maximum profits, the producer needs to use methods or techniques that will help in establishing a good stand and enhance the crop's yield potential. Establishing a good stand is vital. In this lesson, the purpose of tillage, tillage methods, environmental effects, seeding methods, seeding depth, nutrients needed for stand establishment, and factors that affect seeding rates will be discussed.

Tillage

Tillage (cultivating land) is important in the establishment of a crop stand. Generally, there are three main purposes for tillage: to prepare a suitable seedbed, to eliminate competition from weeds, and to improve the physical condition of the soil. Preparing a suitable seedbed refers to the care taken by the producer to prepare the soil to ensure adequate moisture for germination at the appropriate seeding depth. A suitable seedbed should also maximize the soil contact with the seed for water absorption. Eliminating competition from weeds involves the removal of unwanted plants that would compete for the needed nutrients. The soil's physical condition refers to the soil moisture content, aeration, rate of water infiltration, internal drainage, and water holding capacity. The ideal seedbed would provide the optimum environment so that the seed has the best chance to germinate.

Tillage and the Environment

Soil is a precious natural resource. Since there is a limited supply of soil, alternative growing methods are being researched. One method that is used for small-scale production is hydroponics. Hydroponics is growing plants without soil; their essential nutrients are supplied by liquid fertilizers. However, it would be impossible to produce thousands of acres of crops without soil. Therefore, measures must be taken to protect the soil. Soil erosion by wind and water removes an average of 1.6 billion tons of top soil annually from U.S. farm land. This eroded soil runs off into rivers, lakes, and reservoirs where it contaminates these water sources.

There is a growing concern about the effect of certain tillage methods on the environment. Modern technology and equipment enable farmers to use soil-conserving tillage methods. The traditional tillage method that has been used for many years is known as conventional tillage. Conventional tillage involves the use of a moldboard plow, disk, and harrow to prepare the soil. Conventional tillage leaves the soil surface smooth and relatively free of crop residue. It also requires more trips across the field. This method leaves the soil surface exposed and highly vulnerable to water and wind erosion. Farmers are using more soil-conserving methods of tillage rather than the conventional method.

Minimum tillage is considered a type of conservation tillage. Minimum tillage involves the use of a chisel plow, disk, or other implements (equipment). Minimum tillage maintains crop residues and surface roughness, while still providing adequate weed control and seedbed preparation. Minimum tillage increases soil-to-seed contact while decreasing soil erosion.

No-till is another method of conservation tillage. No-till systems leave all crop residue on the soil surface. The no-till methods involve planting seeds directly into the previous crop's residue without exposing the soil. With no-till, good management is important to ensure control of insects and diseases from the previous crop. No-till nearly eliminates soil erosion because all crop residue is left on the soil surface.

Seeding

Once the seedbed is prepared, the field is ready for planting. Seeding methods commonly used are row, drill, and broadcast. When using the row method, seeds are evenly spaced in parallel rows. Corn, potatoes, cotton, tobacco, soybeans, and sorghum are crops commonly planted in rows far enough apart to allow periodic cultivation between the rows. Machines used for planting seed are referred to as planters.

Another method of seeding is the drill method. Drills place seeds in narrow rows at high population rates. Crops such as clover, alfalfa,

wheat, oats, barley, and rye are usually planted by this method. When using the drill method, attachments can be used to place fertilizer at the same time, thus saving time and trips across the field. Planting seed by the drill method reduces the need for mechanical cultivation.

The third method is broadcast planting. Broadcast planters scatter the seed in a random pattern across the top of the soil. Broadcast planting is usually the cheapest method and provides faster coverage for erosion control. Airplanes, tractor-pulled seeders, or hand-held seeders can be used for broadcast seeding. Crops that can be seeded using the broadcast method are grasses, legumes, and small grains. Light tillage is usually required to cover the seeds with a thin layer of soil.

Seed Depth and Fertilization

Depth of seed placement is critical for germination and emergence. Crop producers are interested in having the planted seed emerge as soon as possible to allow photosynthesis to begin. Seed depth depends on: soil type, seed size, type of emergence, soil moisture, and soil temperature. As a rule, larger seeds (e.g., corn and beans) are planted deeper than smaller seeds (e.g., wheat and clover). Larger seeds have more stored food for seedlings to utilize during germination and emergence. Once the seeds are planted, fertilization of the crop is important.

To ensure proper stand establishment, crop producers must anticipate which elements are needed to produce a quality crop. Fertilization can be done by either using a general application, a starter application, or a side dressing. In stand establishment, starter fertilizers are most commonly used. Starter fertilizers, also known as "pop-up" fertilizers, give the most effective results. Starter fertilizers may contain only nitrogen. However, a complete fertilizer consisting of nitrogen (N), phosphorus (P), and potassium (K) is needed for stand establishment. Following the application of a starter fertilizer, a top dressing of a complete fertilizer may also be used. Because of the expense, soil test results should be used to determine the correct application rates and nutrients required.

Seeding Rates

There are many factors related to a productive stand. Using good management practices, crop producers can increase their potential yield. Plant populations refers to the number of growing plants in a given area. The density of growing plants directly influences the yield potential. The desired plant population is dependent upon several factors; one of which is the seeding rate.

Seeding rate refers to the amount of seed planted in a given area (per foot, per acre, etc.). Accurate seeding rates are important. Overseeding wastes seed and underseeding reduces yields. By underseeding, the utilization of available light, moisture, and nutrients is inefficient. Overseeding creates excess competition among the plants, thus reducing yield. Optimum seeding rates should be based on the type of crop, use of crop, pure live-seed ratio, seed quality, soil moisture, soil productivity, time of seeding, method of seeding, row width, and expected average rainfall.

The type of crop being planted influences the desired seeding rate. Corn is typically planted at 18,000 to 24,000 seeds per acre, whereas soybeans are typically planted at a 60-pound-per-acre rate. The intended use of the crop is also a factor. Corn for silage is generally planted at a higher plant population than corn to be harvested for grain.

The pure live-seed ratio refers to the ratio of weight of the viable seed of the cultivar (variety within a plant species) being seeded to the total weight of the seed stock, which may include nonviable seeds, weed seeds, and inert matter. If 80 percent of the seed is viable (able to grow) and it is 95 percent pure, the pure live-seed ratio is 76 percent (0.80 x 0.95 = 0.76). If an individual has 100 pounds of seed, there would be 76 pounds of pure live-seed of the desired cultivar to plant. In order to calculate the correct seeding rate from pure live-seed ratios, reference to the cultivar's recommended seeding rate should be made. An example is presented as follows.

A recommended seeding rate based on 100 percent pure live-seed is six pounds per acre. This rate is common for small-seeded range grasses. The appropriate seeding rate would be

slightly less than eight pounds per acre based on the following calculations:

$$\frac{\text{rate based on 100\% pure live-seed}}{\text{pure live-seed (ratio)}} = \text{seeding rate}$$

$$= \frac{6}{0.76} = 7.9 \text{ pounds per acre}$$

Seeding rate can also be affected by seed quality. Seed quality is based on germination rate and other factors. If seed quality is low, it is advisable to increase the rate of seeding to ensure a good stand. Seeding time refers to seeding the stand at the appropriate time of the season (i.e., fall or spring). Climatic conditions can reduce stand establishment if planted after the optimum time. Increased seeding rates are suggested when planting before or after optimum planting dates.

Soil productivity and soil moisture also affect the optimum seeding rate. Productive soils may sustain the recommended seeding rates where poor soils may only sustain production at lower seeding rates due to the less fertile soil condition. Excessive soil moisture can retard germination. Most seeds cannot tolerate excessive moisture and may rot. If there is excessive moisture, seeds should be planted at a shallower depth and at a higher seeding rate to promote faster germination and to compensate for loss due to wet conditions.

The method of seeding and row width also affect the seeding rate. Row planting usually involves relatively lower seeding rates than the drill method. Broadcast seeding is used when high seeding rates are desired. As a rule of thumb, as row width narrows, the number of seeds planted can be increased to some degree. Conversely, planting seeds in wide rows should be completed at lower seeding rates.

Summary

Successful stand establishment requires careful planning and consideration of many factors. By choosing the appropriate method of tillage, the seedbed can be prepared in a soil-conserving manner. Selecting the proper seeding method, planting depth, use of fertilizer, and optimum seeding rate can make the difference between an average stand and a productive stand.

Credits

Cooper, E.L. Agriscience: Fundamentals and Applications. New York, NY: Delmar Publishers Inc., 1990.

Delorit, R.J.; L.J. Greub; H.L. Ahlgren. Crop Production. 5th ed. NJ: Prentice Hall, 1984.

Chapman, S.R.; L.P. Carter. Crop Production: Principles and Practices. San Francisco, CA: W.H. Freeman and Company, 1976.

Lesson 6:
Managing the Crop

Quality crops are the result of good management. Good crop management decisions involve fertilizer use and application, pest control measures, soil pH and adjustments, tillage, treatment of crop residues, and the proper use of irrigation. Producing quality crops at a profit requires planning and the use of sound management practices.

Elements Needed for Plant Growth

There are 16 nutrient elements that are required for plant growth. Each of the elements performs specific tasks. Carbon, hydrogen, and oxygen are essential in the process of photosynthesis and respiration. They are not generally applied as fertilizer. The other 13 elements are important for many plant functions.

The 13 nutrient elements can be categorized according to the amounts needed by plants. The major elements, commonly called macronutrients, are nitrogen (N), phosphorus (P), and potassium (K). These three nutrients are most commonly applied to crops. Calcium (Ca), magnesium (Mg), and sulfur (S) are considered secondary macronutrients. The other seven mineral elements, known as micronutrients, are boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), and chlorine (Cl).

Application

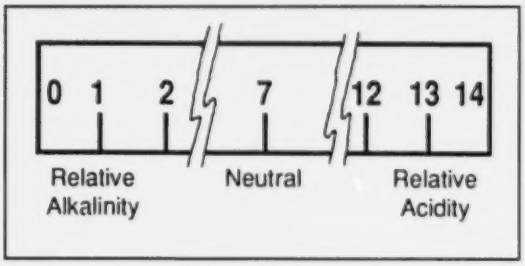
The amount of fertilizer applied should be based on the soil test results. Fertilizers are expensive. Some fertilizers are petroleum-based, and applying them incorrectly can be very costly. After considering the results of a soil test, more effective management decisions can be made regarding soil nutrient needs and applications.

Fertilizer may be applied at the time of planting with a starter fertilizer. Starter fertilizer may consist of nitrogen only or a complete fertilizer containing N, P, and K. Side-dressed fertilizers may be applied after the plant seedlings have emerged and vegetative growth has begun. Top-dressed fertilizers are applied after plants have become established. The amount and application method vary because of cultural practices, soil type, type of crop, and personal preference. Information relating to production of specific crops can be obtained from seed companies. However, soil tests are vital for good management decisions and should be completed well before planting.

Soil pH

Soil pH refers to the degree of acidity or alkalinity of a soil. The pH scale ranges from 0 (maximum acidity) to 14 (maximum alkalinity). At the midpoint of the scale (7), the pH is considered neutral, meaning neither acidic nor alkaline. (Figure 6.1).

Figure 6.1 - pH scale



Profitable crop production is dependent on soil pH. Most crops grow and produce the best in soils with a pH range of 5.0 to 7.5. Soils with a pH outside the 5.0 to 7.5 range inhibit the absorption of nutrients by growing plants. When planning for crop production, the soil's pH should be tested at least every three years. Once the pH is determined, measures can be taken to adjust it to a desirable level.

Altering the pH can be accomplished by applying lime or sulfur depending on the needed change. If the soil is too acidic, application of agricultural lime will raise the pH. The amount of agricultural lime needed varies depending upon the amount of organic matter, soil texture, and current pH level of the soil. The greater the organic matter and clay, the more lime required. More acidic soils also require greater amounts of lime to raise the pH to an acceptable level.

If the soil is excessively alkaline, application of sulfur or aluminum sulfate will lower the pH. In

land where production has occurred before, excessive soil alkalinity may be caused by heavy applications of lime or by applying lime to soils with a high pH. Applications of sulfur will lower alkalinity of soils in an average of 3 to 6 months. Applications of aluminum sulfate will change soil alkalinity within 10 to 14 days. When using agricultural lime, sulfur, or aluminum sulfate, care should be taken not to use more than what is needed. The crops to be produced, fertilizers used, and cultivation practices after harvest are factors to consider when attempting to alter a soil's pH.

Crop Residues

After harvesting crops, farmers are faced with the decision of how the plant residues should be handled. Plant residues are the unused parts of the crop that are not harvested (e.g., straw, corn stalks, and soybean hulls). A major component of soil is organic matter. Organic matter is important because it is the basis of soil productivity. Crop residues are often tilled into the soil to increase soil organic matter, which raises the nutrient-holding capacity, water-holding capacity, and physical condition of the soil. Most Missouri soils contain less than three percent organic matter, whereas other states like Illinois have five percent or more of organic matter. Crop residues can also be left on the surface, which will greatly reduce the amount of soil erosion due to wind and water. Crop residues left on the soil surface reduce the force of the rain and slow the travel of water across the surface. Crop residues help hold the soil particles together, which also reduces erosion by wind.

Pest Control

Farmers lose billions of dollars annually because of crop pests. Crop pests include diseases, weeds, insects, and animals. Crop pests may damage crops by destroying the seed, attacking the live plant, or contaminating the harvested crops. Crop pests may reduce yields, reduce quality, and damage crops in storage. Methods of controlling plant pests involve mechanical, cultural, biological, genetic, and chemical means.

Mechanical control refers to practices that disrupt the pest's environment or the pest itself. Cultivation exposes soil-borne pests to the air and sunlight and controls weed. Mowing, electricity, and traps are also considered mechanical control methods.

Cultural control refers to adapting agricultural production practices to control pests. Pests can be controlled by planting resistant crop varieties, rotating crops, and timing certain operations to break the reproductive cycle of specific pests.

Biological control involves the use of predators or diseases that affect only the pests. Genetic control is done through the development of crop varieties that are resistant to pests.

Chemical control of pests is accomplished through the use of pesticides and other chemicals. Care must be taken not to use excessive dosages because of the increased chance of soil and water pollution due to runoff. Pesticide application should be performed by experienced persons and according to recommended rates.

Irrigation

In many states, the average annual rainfall is not adequate to sustain intensive crop production. There are also years where rainfall in some areas is not sufficient due to drought conditions. When these situations arise, steps may be taken to supply adequate water to the crops.

Irrigation is a technique of supplying water to plants, which has been used for thousands of years in many parts of the world. Although irrigation is not a new technique, some of the methods have greatly improved. Irrigation provides water for crop production through aerial, surface, and subsurface methods.

Aerial irrigation generally refers to the use of sprinkler systems. Aerial irrigation involves the use of permanent or portable pipes. High volume equipment such as center pivot systems are used in the western parts of the U.S., where rainfall is limited.

Surface irrigation moves water directly from the source to an area where the crops are. The surface methods include flood, drip, furrow, and corrugation irrigation. Surface irrigation uses various methods to move the water across the soil surface to the crops.

Summary

Managing a crop involves making decisions related to assessing nutrient needs of crops, fertilizer application, pests control, soil pH, handling crop residues, and irrigation. Each factor can enhance or restrict the crop's potential for high yields. Good crop management considers each of the factors that affect crop growth.

Credits

Cooper, Elmer L. Agriscience: Fundamentals and Applications. Albany, NY: Delmar Publishers Inc., 1990.

Fridline, Clarence R. Field Crop Nutrition. The Ohio State University: Ohio Agricultural Education Curriculum Materials Service, 1978.

Chapman, S.R.; L.P. Carter. Crop Production: Principles and Practices. San Francisco, CA: W.H. Freeman and Company, 1976.

Delorit, Richard J.; Louis J. Greub, and Henry L. Ahlgren. Crop Production, (5th ed.) Englewood Cliffs, NJ: Prentice-Hall, 1984.

Lesson 7:
Harvesting and Storing Grains

Use of proper grain harvesting procedures is necessary to ensure that farmers are able to harvest all of the grain they produce. Harvesting time and methods, storage requirements, and grain drying procedures will be topics of discussion in this lesson.

Harvest Time

Determining the optimum harvest time is critical for profitable grain production. The best time to harvest is when the producer receives the highest yield of the highest quality. Choosing the correct time to harvest can be the difference between profit or loss. Factors that determine the proper time to harvest grain crops can be divided into three categories: plant characteristics, climatic factors, and harvesting methods.

Plant characteristics refer to the plant's stage of maturity, tendency to lodge (bending or breaking plant stems), and tendency to shatter (the loss of grain, or seed, from the inflorescence, or head). Delaying harvest beyond the optimum time decreases yield and increases the possibility of loss due to lodging and shattering.

Climate is also a consideration in harvesting because of the effect it has on mature crops. Rainfall, humidity, wind, and temperature affect crop moisture content. Harvesting crops with a high moisture content may increase storage losses due to molding and overheating. Adverse weather conditions can also damage crops that are ready for harvesting. Also, grain harvesting equipment may not be usable in muddy fields.

The harvesting method used will also influence the optimum harvest time. Windrowing small grain crops may allow for earlier harvesting since the crop moisture is reduced somewhat in the windrow before threshing. Grains dry more quickly in a windrow than as standing crops. Combining standing grain will generally result in harvesting at a higher moisture content than with the windrow harvesting method. However, windrow harvesting may increase losses due to shattering. Optimum harvest times vary with the crop and its anticipated use. Table 7.1 identifies the characteristics that indicate the proper harvest time for common grain crops.

Table 7.1 - Characteristics of Proper Harvest Time

Crop	Percent Moisture	Plant Maturity Stage	Physical Plant Signs for Harvest	Method Used to Harvest
Wheat	below 14%	a little past hard dough stage	majority of kernels shell out when rubbed between hands	direct combine
Oats	no more than 13-14%	hard-dough or 2-3 days later	when the straw shows no greenness and the heads have turned a dull white	direct combine or windrow-pickup combine
Barley	below 14%	hard-dough stage	when heads have turned golden yellow but straw may be slightly green	direct combine or windrow pickup combine
Corn (grain)	15.5%	50-60 days after pollination	kernels are nearly all well glazed and dent corns, well dented-husks and bottom leaves dry, upper leaves 1/4 to 1/2 green	direct combine
Corn Silage	65-70% (for plant)		kernels well glazed, and husks begin to turn yellow although most leaves are green	field chopped

Grading Grains

In 1916, the U.S. Grain Grading Act was passed, requiring that all grain shipped to or from the U.S. be inspected and graded. Specific procedures for sampling grains were established. Grain samples were used to assign a class and grade for marketing purposes.

Factors used in federal grain grading are: class, test weight per bushel, percentage of damaged grain, percentage of foreign materials, and percentage of other classes. Class refers to the varieties that exist in each type of grain crop. For example, wheat consists of seven classes. These classes are hard red spring wheat, durum wheat, red durum wheat, hard red winter wheat, soft red winter wheat, white wheat, and mixed wheat. Some classes may have subclasses. Grain crops may have from one to several classes. For example, flaxseed has only one class whereas wheat has seven classes.

Determining the classification is part of the grain grading process. The weight of a grain sample is used in estimating the moisture content and percentage of dry matter. Percentage of damaged seed (grain) is estimated as a percentage of the sample and then extrapolated to the whole shipment. Percentage of foreign material refers to weed seeds, weed plant parts, insect parts, or any material other than the seed. The percentage of other classes includes any other class of grain that is found in the shipment. All of these factors are considered when determining the grade of a grain sample. The market price for grain is based upon the grade classification of a representative sample of grain.

Grain Quality Factors

Factors that determine grain quality are purity of crop and variety, percentage of weeds and other mixtures, and percentage of diseased and damaged kernels. Each of these factors influences the quality of a grain sample.

Methods of Harvesting

Methods of harvesting vary with the type of crop. Methods most commonly used are direct combine method and windrow-pickup combine method. The direct combine method utilizes combines with interchangeable gathering units (heads) depending on the crop. The direct combine method involves cutting and threshing (the separation of grain from the rest of the plant material) the standing grain in the same operation. With direct combining, the threshed grain can be held in a hopper on the combine.

The windrow-pickup combine method places the cut, but unthreshed crop in rows for field drying. After the grain has dried in the windrows, it is gathered by a combine equipped with a pickup attachment. After the threshed grain is accumulated in a hopper, it is then loaded into grain trucks for transportation.

Improperly Stored Grain

Much of the profit potential from grain production can be lost due to improper storage. Economic loss during storage may be caused by high moisture content, heat damage, rotting, improper drying, foreign material, and insect and rodent infestation. Mold can be a problem if grains are harvested and stored when the moisture content is too high. If moisture content is too high, the grain will heat up, encouraging rotting and spoilage. Foreign material in the grain such as weed seeds, plant parts, and insect parts can encourage grain spoilage. If adequate storage is not provided, insects and rodents can infest the grain and reduce the quality by contamination.

Maintaining Crop Quality

Maintaining crop quality can be accomplished using good management practices. The primary goal of a grain storage facility is to retain the quality of stored grain. Several steps can be taken to maintain crop quality: harvesting grain at the proper moisture content; properly constructing and maintaining storage bins; protecting against pests; providing proper ventilation; protecting from fire and wind damage; and inspecting the grain frequently.

Harvesting grain at the proper moisture content is vital for good storage. The maximum moisture content for various grains follows: shelled corn grain, 13 percent; hard red spring wheat, 13 percent; soft red winter wheat, 12.5 percent; hard red winter wheat, 12 percent; and soybeans, 13 percent.

Properly constructed and maintained storage facilities reduce grain spoilage. Cleaning and disinfecting facilities between storage seasons discourages entry by pests. Providing proper ventilation also decreases the possibility of grain deterioration. Frequent inspections are also recommended to prevent losses due to unexpected problems.

The facility should provide protection against fire and wind damage. Other factors to consider would be the convenience to fill, empty, and inspect. The facility should be structurally sound and able to withstand lateral pressure when full. For example, there are approximately 300 pounds of lateral pressure per square foot on the bottom wall of a 2,000-bushel round bin that is 16 feet in diameter by 12 feet deep. All of these factors should be considered when deciding on a storage facility.

Drying Grain

The ability to dry harvested grain in storage provides many advantages to grain producers. Early harvesting may be necessary to avoid weather conditions that would contribute to excessive harvest losses. Market prices, which may be higher early during the harvest time, decrease as the harvest season progresses. Artificial drying can help reduce losses from molds, heat damage, and spoilage due to high moisture content. Drying grains in storage to the proper moisture content helps to maintain crop quality. The methods of drying grain crops are drying with unheated air, drying with heated air, and drying in the field.

Unheated air may be used to dry harvested grain that contains no more than 15 percent moisture. Unheated air must have a relative humidity of 70-75 percent or less to decrease the grain moisture content. During the final drying stages, unheated air must contain less than 50-60 percent humidity to reduce the grain moisture content to 13 percent. Bins for drying must be equipped with perforated ducts or false floors to allow the air to be forced through all parts of the bin by a ventilating fan.

Advantages of drying with unheated air include lower expense for energy, less fire hazards, lower initial equipment costs, little management and supervision, and less chance of overdrying. Disadvantages arise because the unheated air uses outside air which is affected by natural weather conditions. Unheated air systems are not effective in cold, damp conditions. Other disadvantages are slower drying rates, more drying time required, and greater possibility of damage from mold due to prolonged drying times.

Drying with heated air is accomplished by heating the air with natural gas or petroleum fuels and forcing the heated air throughout the storage bin. The heat from each gallon of fuel will evaporate 50 to 85 pounds of water from the grain if direct heat drying is used. If indirect heating is used, 35 to 60 pounds of water can be removed.

The advantages of using heated air are increased ability to dry the wettest grain, no dependency on weather conditions, shorter and faster drying times, and high drying capacity. The disadvantages of using heated air drying are higher initial cost, higher fuel expense, some fire hazard, potential to overdry grain (thus reducing quality), and requires more careful management and supervision.

In field drying, the crop is allowed to dry to the appropriate moisture content while standing or after cutting, conditioning, and windrowing. The standing crop is harvested with the appropriate combine head attachment. Windrowed crops can be picked up once they reach the correct moisture content using a combine windrow-pickup attachment.

Summary

Successful on-farm grain processing involves proper harvesting and storage. Producing and marketing grain of high quality is a result of good management decisions. Decisions that consider proper harvesting times, harvesting methods, and storage methods that maintain grain quality, are important in the overall grain production process.

Credits

Delorit, Richard J.; Louis J. Greub; Henry L. Ahlgren. Crop Production. 5th ed. NJ: Prentice-Hall, 1984.

Kipps, M.S. Production of Field Crops. 6th ed. NY: McGraw-Hill, 1959.

Brickbauer, E.A.; W.P. Mortenson. Approved Practices in Crop Production. Danville, IL: The Interstate Publishers and Printers, 1978.

Lesson 8:
Harvesting and Storing Forages

There are more acres in the U.S. used for the production of forage and pasture crops than for any other agricultural purpose. Forages are crop plants that are grown or produced for animal feed. Production of forages takes place on more than 475 million acres of pasture or range land in the U.S. An additional 60 million acres are used for intensive hay production. Missouri is the second leading state in the nation in hay production (excluding alfalfa). Missouri produces an estimated 6.7 million tons of hay each year.

Many factors are involved in harvesting and storing forages. Supplying quality forages for livestock feed requires forage producers to make decisions regarding when to harvest, which harvesting method to use, and how to store forages to maintain quality. The term harvesting includes direct grazing, cutting for dry or high moisture systems, and baling.

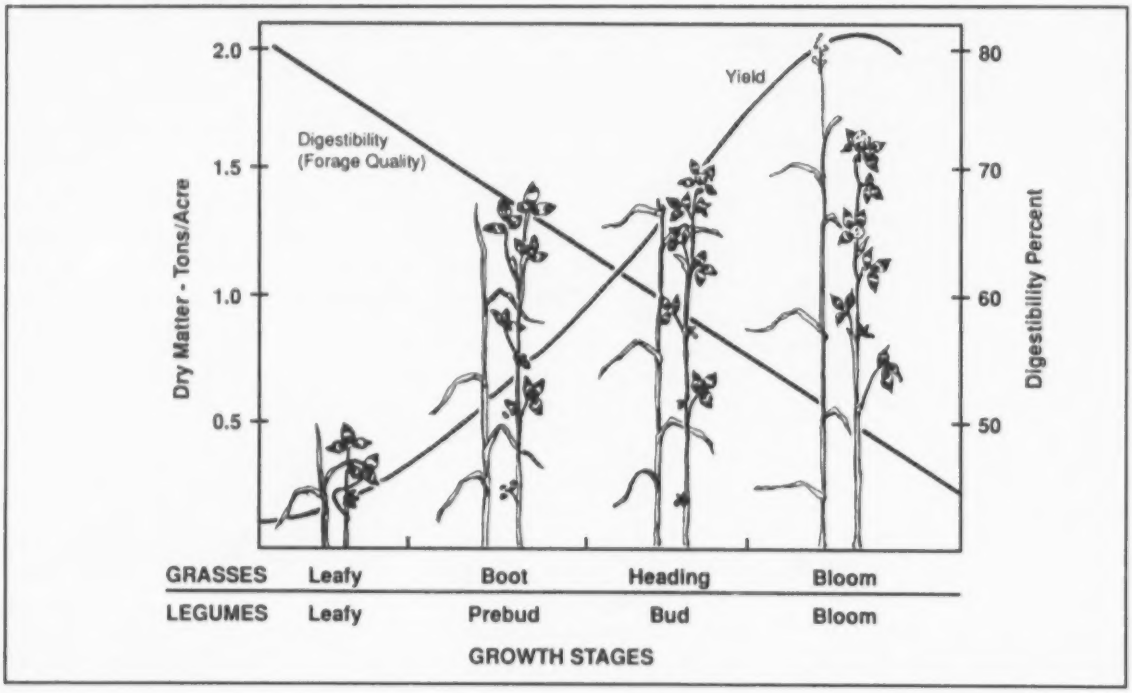
Determining Harvest Time

Quality forage crops originate from quality seed. However, forage quality can be reduced if cutting and baling are done improperly or if weather conditions are not favorable. The nutrient content and palatability (taste) of forages are important; therefore, harvesting must occur at the optimum time.

Forage nutrient value is at its highest level at an early growth stage; however, yield would be low at that time. A balance must be reached between nutrient content and yield when considering the best time to harvest forages. (Refer to Figure 8.1.) Cutting early will reduce yield but produce the highest quality. Cutting later increases yield but reduces quality. If cutting is delayed, leaf drop and lodging (plant falling over on the ground) may become problems. The optimum time to harvest forages depends on the plant species. (Refer to Table 8.1.)

Optimum time for baling forages is equally important to ensure quality. Baling too early

Figure 8.1 - Yield and Quality in Forages



when the forage is wet may cause mold and heat damage. Delaying baling past the optimum time may result in leaf shattering and a reduction in forage quality. Measures must be taken to estimate the optimum time to bale in order to avoid these problems. Figure 8.1 shows yield and quality at different growth stages of forage grasses and legumes.

Weather conditions should also be considered. Forage cutting can be hindered and forage quality reduced by undesirable weather conditions. Cutting hay before or during rain is detrimental to the nutrient quality of the forage. Rain will leach out nutrients from cut forage.

Determining Forage Quality

Forages can be consumed by livestock through pasture grazing or in the form of hay, haylage, or silage. Hay includes the entire vegetative part of a forage crop dried for feed. Haylage is cut forage stored in airtight systems at a higher moisture content. Silage is a forage crop preserved in a succulent state that ferments and is used for feed. Forage quality is important in order to supply nutrients to livestock.

The quality of forages affects milk production levels in dairy cattle and rate of gain in livestock. Care must be taken to provide quality forages. Factors that determine forage quality can be assessed by physical appraisal or chemical analyses.

Physical appraisal is the most common method used. It uses sight, smell, and touch when determining the quality of a forage. The three main characteristics that determine the quality of hay are visual appearance, color, and odor. Good quality hay should consist of a leafy forage that is not dominated by coarse large stems. Quality forages should also be free of foreign material.

Color can be used to judge whether or not the forage has been damaged or improperly dried. The appropriate color of quality hay should be a bright green. The odor of hay should be pleasant. A musty or moldy smell would indicate damage due to excessive moisture or heat damage.

Chemical analyses are used when knowledge of the precise nutrient content of a forage is important. Scientists use chemical analyses to

Table 8.1 - Hay Types and Optimum Time to Cut

Type of Hay	Optimum Time for Harvest
1. Alfalfa	first flower to 1/10 bloom
2. Alsike clover	1/2 to full bloom
3. Birdsfoot trefoil	1/10 bloom
4. Cowpeas	when first pods have started to ripen
5. Corn silage	harvest when kernels are fully dented and glazed
6. Crimson clover	1/2 bloom
7. Fescue	boot to early heading
8. Ladino clover	full bloom
9. Lespedeza	early bloom
10. Medium red clover	1/4 to 1/2 bloom
11. Small grains	boot stage to early dough
12. Soybeans	when beans in the pod are half developed
13. Sweet clover	when first blossoms appear
14. Bromegrass	early bloom (anthesis)
15. Orchardgrass	fully headed but before bloom
16. Reed canarygrass	when first heads appear
17. Timothy	early bloom (anthesis)

determine the levels of crude protein in a forage sample. Such information is needed to prepare a balanced feed ration that provides maximum animal performance. Digestibility is estimated by chemically analyzing the fiber content in the forage. Digestibility relates to the ability of animals to digest the forage. Chemical analyses are also used to determine the lignin content of forages.

When to Harvest Forages

Refer to Table 8.1, "Hay Types and Optimum Time to Cut," for information. Note that the optimum harvest time occurs before the crop reaches physical maturity.

Methods of Harvest

When harvesting forages, the use of the forage influences the best method of harvest. Forages to be used for grazing must be managed to provide feed for the number of animals which will be grazing the field. Grazing too many animals on a pasture can damage the forage crop stand and lead to soil erosion. Pastures managed properly by rotation grazing increases forage production and protects the soil.

Dry hay harvesting systems involve cutting the forage, drying it in the field (curing) and packaging it for transportation and storage. Methods used to package forage crops vary, depending on how the crop is to be used or stored. Common methods of packaging are conventional square or round bales, large round bales, large rectangular bales, portable haystacks, and field cubes. Each method uses different equipment and results in products of various weights and sizes. The preferred packaging method is dependent on the needs of the producer.

There are several steps in the hay harvesting process. The first step involves cutting the forage at the optimum time. After cutting, the forage can either be left in the swath (cut path) or raked into rows (windrows). Cutting can also be done by using a mower-conditioner. Mower-conditioners cut the forage, crimp or crush the stems, then windrow it to dry. Conditioning forages speeds up the drying process. Once the forage is dried to the desired moisture level, it is then baled, stacked, or cubed for storage. Chemical additives can be used to reduce drying time and the formation of molds.

High moisture systems involve cutting forages at higher moisture levels (40-75%) and storing them in airtight silos, bunkers, or bags. When forages are cut for silage, they should contain approximately 60-75 percent moisture content. Haylage is stored at 40-60 percent moisture content in an oxygen-free atmosphere. High-moisture silage is generally harvested with a mechanical chopper. The chopper cuts the standing forage crop into short lengths and blows it into a truck or wagon that is trailing behind the chopper. The freshly chopped forage is then taken to a silo and stored until needed for feed. Wilted silage or haylage is allowed to dry to proper moisture before storage.

Specialized forage processing machinery can be used to produce cubes or pellets. Stationary cubers force ground forages through extrusion dies to form cubes. Stationary cubing requires expensive machinery and much labor.

Pelleting machines produce pellets that vary in length. Pelleting machines use ground forages. Pellets are used for small animal feeds such as rabbits, sheep, and poultry. Alfalfa is a common forage used for pellets and is a primary protein source in mixed feeds.

Forage Deterioration

Forage deterioration can be caused by improper cutting, improper baling, improper harvesting methods, and improper storage. Early baling can cause forage deterioration due to high moisture content. Mold and heat damage will occur, causing deterioration. Mold and heat damage reduce the quality and palatability of forages.

Improper storage can also cause forage deterioration. Facilities that do not protect forage crops from heat damage, weather, or pests increase deterioration of stored forages. Deterioration of forages can be a costly problem. Steps should be taken to prevent forage deterioration.

There are four main steps that should be taken to reduce forage deterioration. First, to ensure quality forage, the crop must be harvested at the

optimum time. Second, the appropriate harvesting method should be used to help maintain feed value. Conditioning cut forages can reduce drying time and limit field damage from pests or adverse weather. Methods that reduce the loss of leaves from the plant should be used since leaves contain most of the nutrient value of forage crops. If leaves are lost through drop or shattering, forage quality is reduced. Harvesting forages at the proper moisture content will help to maintain forage quality during storage. Maintaining proper storage facilities is the fourth important step to prevent forage deterioration.

Storage Requirements

The effort, time, and expense required to produce a quality forage crop can be wasted if it is improperly stored. The basic requirements for storing dry hay are to provide protection from weather, insects, animals, and birds and to provide adequate ventilation. For silage and haylage, protection from weather, insects, animals, and birds must be provided. However, silage and haylage require air-tight facilities because of the fermenting action which occurs during storage. Silage and haylage storage facilities should also provide for convenient filling, emptying, monitoring, and cleaning.

Improving Field Drying

Forage crops, when cut in the field for hay, should contain 15-20 percent moisture for baling. Methods used for field drying are swath drying, windrow drying, crushing or conditioning, and chemical additives.

In swath drying, the forage is left in the path it was originally cut to sun dry. Once dry, the swath is raked into windrows to be picked up and baled. Windrow drying involves cutting the forage and raking it into rows, allowing it to dry in the rows before baling. Both techniques are commonly used. Swath drying can cause bleaching of the forage if not done properly. Bleaching reduces the quality of the forage and causes the forage to lose much of its green color.

Crushing or conditioning is also a method used for field drying. The forage is cut by a conditioning machine that either crushes or crimps the stems to speed up the drying process. Conditioners place the crimped forage in windrows. Since a shorter field drying time is required, the chance of bleaching or damage from other sources is reduced. Chemical additives such as calcium carbonate can speed up the drying time and reduce nutrient losses from overexposure to sunlight. Other chemicals such as organic acids (i.e., propionic acid) can be used to prevent molding, thus permitting the forage to be baled at a higher moisture level.

Summary

Forages provide vital nutrients to many species of livestock. Millions of acres in the U.S. are devoted to the production of forages. Forages may be produced on pastures, on range lands, or in intensive hay crop production. Producing quality forages such as hay, silage, and haylage requires good management practices. Proper cutting time, baling time, harvesting methods, and adequate storage are important factors to consider in producing quality forages.

Credits

Cooper, Elmer L. Agriscience: Fundamentals and Applications. Albany, NY: Delmar Publishers, Inc., 1990.

Heath, M.E.; R.F. Barnes; D.S. Metcalfe. Forages: The Science of Grassland Agriculture. 4th ed. IA: Iowa State University Press, 1985.

Delorit, R.J.; L.J. Greub; H.L. Ahlgren. Crop Production. 5th ed. NJ: Prentice-Hall Inc., 1984.

Chapman, S.R.; L.P. Carter. Crop Production: Principles and Practices. San Francisco, CA: W.H. Freeman and Company, 1976.

Lesson 9:
Controlling Crop Pests

Crop pests destroy billions of dollars of crop plants each year. Pests also spoil billions of dollars of stored crops each year. Controlling crop pests is a major field of study in agricultural research. Methods and practices have been developed that reduce the damage caused by pests. This lesson will present common methods of crop pest control.

Pests

Most consumers consider the term pest to mean an insect. However, to crop producers, the word pest takes on an expanded meaning. Pests that affect plant growth may include weeds, insects, and plant diseases. Plant pests are organisms that inhibit or prevent plant growth.

It is a good crop management practice to prevent plant pest damage before it starts. However, in some situations, it is necessary to reduce the effect of plant pests after some damage has begun. Methods of control vary, depending on the type of pest.

Weed Control

Control methods for weeds include hand, mechanical, chemical, and biological methods. Hand methods involve pulling weeds out by hand or hoeing weeds out with hand tools, which is extremely effective. However, this method cannot be done on a large scale. Mechanical methods are similar to the hand method, except it is completed using tractors and cultivation equipment.

Chemical methods involve the use of chemicals to control plant pests. Herbicides are used to control weeds with minimum damage to crop plants. Selective herbicides are designed to destroy specific plants based on how crops and weeds absorb and break down chemicals. Selective herbicides may be used to control broadleaf weeds (e.g., cockleburr, mustard) that are growing among grasses (e.g., corn, oats). The amount of herbicide used must be closely monitored to avoid injury to crop plants.

Biological methods are also used to control weeds. Biological control is growing in popularity because of the concern for the environment. In nature, there are specific insects, weeds, and diseases that inhibit the growth of other insects, weeds, and diseases. Researchers in this area continue to discover means by which biological control can be used to control pests in crops.

Insect Control

Insects vary in the way they damage crop plants. Some insects chew on plant parts. Others suck the juices or bore into the plant. Because of these differences, methods of control must also vary. Methods used to control insects include genetic, cultural, biological, and chemical practices.

Genetic control involves the development of cultivars (variety within a species) of crops that are resistant to common insects. One example is the wheat stem sawfly. The wheat stem sawfly attacks the hollow stem of wheat. Crop researchers discovered that wheat varieties with solid stems were not attacked by the sawfly. Plant scientists have manipulated the genetic makeup of hollow stem wheat varieties by incorporating genes that produce a solid stem. From this work, a wheat variety was developed that has the good characteristics of hollow stem wheat combined with the solid stem. Therefore, the sawfly does not attack this new variety. This genetic method to control the wheat stem sawfly has proved to be successful.

Cultural control methods involve the modification of production practices. Examples of cultural control include crop rotation to break the reproductive life cycle of insects or adjusting planting and harvesting dates to break the life cycle of insects.

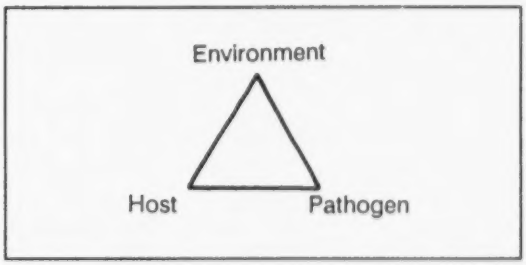
Biological control may use predator insects to inhibit plant damaging insects. Genetically sterile, mutant insects may be released to spread through the population of harmful insects and reduce their reproductive potential. Other biological controls involve releasing a disease into an insect population which in turn infects other insects. Such biological control methods must be carefully monitored to prevent the introduced insects from becoming pests.

Chemical control involves the planned use of insecticides to combat insects in crop plants. Insecticides are applied in the form of sprays, dusts, and gases. Chemical methods of insect control must be closely monitored to protect the environment and human health.

Disease Control

Crop yields can be reduced due to plant diseases. Plants are subject to many diseases. In order for a disease to start, three conditions must be present: a suitable environment, a viral pathogen (organisms which produce disease), and a susceptible host. This relationship of three factors is referred to as the disease triangle. (See Figure 9.1 - Disease Triangle.)

Figure 9.1 - Disease Triangle



Plant diseases are usually caused by fungi (plural for fungus). Fungi do not contain chlorophyll. Because fungi have no chlorophyll, they depend on green plants for food. Damage to plants by fungi can involve the entire plant or localized areas. Methods of controlling fungi are genetic, cultural, chemical, and isolation.

Pesticide Safety

There is wide concern in the U.S. for the environment and human health. The use of chemicals in crop production is under scrutiny. In 1988, over 820 million pounds of pesticides were used in the U.S. Over six billion dollars were spent on chemicals to control insects, weeds, and diseases. Considering the volume of use, individuals applying pesticides should be trained to use them properly.

Care must be taken when working with pesticides. Safety procedures should be followed when handling and applying pesticides. Some general safety rules are as follows:

1. The applicator should be trained in pesticide application.
2. Carefully read and follow pesticide label directions.
3. Understand toxicity ratings, signal words, and symbols.
4. Wear appropriate protective clothing and use protective equipment.
5. Store pesticides properly.

Toxicity ratings, signal words, and symbols should be read and understood. These ratings are based on LD_{50} (lethal dose) and LC_{50} (lethal concentration) values. The LD_{50} and LC_{50} ratings refer to the amount of chemical that is required to cause death in 50 percent of a test population of laboratory animals. The lower the LD_{50} value, the more toxic the pesticide. Word labels such as "DANGER-POISON," "WARNING" and "CAUTION" relate to the relative hazard of the pesticide to the handler.

Using special protective equipment and clothing when handling pesticides is very important. The human body can absorb some pesticides very quickly. Pesticide absorption through the skin is known as dermal absorption. For protection, the following safety equipment should be worn when using pesticides: clear face shield, goggles, rubber gloves, respirator, boots, wide-brimmed hat, rubber apron, and lightweight coveralls.

Proper storage of pesticides is critical to minimize the risk of accidental poisoning. Improperly stored pesticides are a safety hazard. Storage areas should be well-ventilated, locked, fireproof, and properly marked. Each pesticide should be stored separately and on different shelves. Do not place pesticides in unmarked jars or soda bottles. Keep labels in good condition, on the original container, and keep records of pesticide applications.

Environmental concerns about the use of pesticides have brought about many changes. Awareness of the risk to human health and the environment has prompted the Environmental Protection Agency (EPA) to restrict the use of some chemicals. Use of pesticides on food products must follow strict guidelines to limit

chemical residues. Most pesticides are expensive, and improper application can be very costly. Because of the concern for safe food, care should be taken to use pesticides safely.

Integrated Pest Management

Integrated Pest Management (IPM) is a technique of controlling pests using multiple pest control practices. IPM is used in agriculture by establishing levels of "acceptable" and "not acceptable" pest infestation in a crop (economic thresholds). Once these economic threshold levels have been established, they are used to determine the need for pest control treatment. Below the economic threshold, control measures cost more than the economic loss caused by the pest. Above the economic threshold, the loss caused by the pest exceeds the cost of controlling the pest.

IPM strategies focus on key pests and their biological characteristics, including weaknesses, crop biology, and the relationship between a crop and its ecosystem. Techniques of manipulating ecosystems by introducing pest-resistant cultivars and the establishment of economic thresholds have been very successful. Using crop scouts, data can be collected to match the method of control with the particular pest, crop, and ecosystem.

IPM involves the use of a variety of regulatory control techniques. Regulatory control measures are designed to prohibit the spread of pests into uninfested areas. Regulatory control includes the use and enforcement of quarantine or isolation techniques. IPM researchers are working toward the development of disease-resistant cultivars for commercial use. Other control techniques used in IPM are biological, cultural, physical, mechanical, and chemical control. IPM is effective in controlling crop pests. By conducting research on pests, crops, and their relationship with the ecosystem, greater control can be achieved.

Summary

Controlling crop pests involves controlling weeds, insects and diseases. Control can be achieved by means of hand and mechanical methods as well as genetic, cultural, biological, and chemical methods. Chemical control has become the most common method of controlling pests. However, it has become the most controversial because of the potential hazards to human health and the environment. Safety is very important when using chemicals.

Another technique used in crop pest control is the integrated pest management (IPM) system. IPM utilizes professionals in entomology, pathology, agronomy, and horticulture. These experts collect research data on pests, crops, and their relationship to the ecosystem. IPM works to control crop pests by combining multiple control techniques.

Credits

Cooper, E.L. Agriscience: Fundamentals and Applications. Albany, NY: Delmar Publishers, Inc., 1990.

Fridline, C.R. Field Crop Nutrition. The Ohio State University: Ohio Agricultural Education Curriculum Materials Service, 1978.

Chapman, S.R.; L.P. Carter. Crop Production: Principles and Practices. San Francisco: W.H. Freeman and Company, 1976.

Delorit, R.J.; L.J. Greub; H.L. Ahlgren. Crop Production. 5th ed. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1984.